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TABLE OF CONTENTS.

	Page.
LEADING ARTICLES:	
A New Water-Supply for the City of Vancouver, B. C. (illustrated); H. M. Burwell	337
Original Work of the Bureau of Explosives, American Railway Association; W. Dunn	340
Failures in Concrete Sidewalks and How to Correct Them (illustrated); L. J. [illegible]	342
Standard Specifications for Portland Cement Sidewalks of the National Association of Cement Users	344
The Determining of a Reinforced-Concrete Dam at Pittsfield, Mass. (illustrated)	345
The Average Speed and Cost of Moving Freight by Rail and by Canal	347
The Deepest Metal Mines of the World	348
Grade Crossing Elimination; A. D. Chidsey, Jr.	348
Failure of Two Iron Water Tanks at Parkersburg, W. Va. (illustrated); William M. Hall, M. Am. Soc. C. E.	350
Questions Used in Examination for Inspectors of Streets and Sewers, San Francisco Board of Public Works, Feb. 20 and 27, 1909	351
A New Machine for Inserting Valves in Water Mains Under Pressure (illustrated)	352
The "Conservation" Meeting of the National Engineering Societies: Addresses by John R. Freeman; H. W. Raymond; C. W. Baker, and L. B. Stillwell	361
Report of the Boston Metropolitan Improvement Commission	364
EDITORIAL	353
The Bureau of Explosives and the Work for Public Safety—A Hint to Building Law Framers.	
Newspaper Comments on Engineering Work	353
Suggested Improvements for the Boston Metropolitan District	353
Concerning the Gatun Dam and Earth Dams in General (illustrated)	354
LETTERS TO THE EDITOR	358
Flat-Plate vs. Beam-and-Slab Construction for Reinforced-Concrete Floors; C. A. P. Turner—Repairing a Break in a Mattress Bank Protection (illustrated); F. Y. Parker—Canadian Routes for Deep Waterways Between the Great Lakes and the Atlantic; E. A. Forward—Constitutional Prohibitions Against Tree Cutting and Land Flooding on New York Forest Lands; E. M. Clarke—Experience with the California Law for Licensing Surveyors; V. C. Noddin.	
ENGINEERING NEWS OF THE WEEK	366
PERSONALS	368
ENGINEERING SOCIETIES	368

A New Water-Supply for the City of Vancouver, B. C.

By H. M. BURWELL.*

The city of Vancouver, B. C., has heretofore depended on its water-supply from Capilano Creek, a mountain stream emptying into the northerly side of Burrard Inlet at a point about a mile and a half from the city. This supply has been adequate up to the present time, but owing to the rapid increase in the population recently, the necessity of securing water from another source of supply was apparent for the following reasons: (1) The extreme low-water stage in the Capilano would not be sufficient for the future population. (2) Owing to the rapid fall of this creek it would be impossible to create storage reservoirs in its narrow valley at a permissible cost. (3) And finally, the crossing of the supply main under the First Narrows (being the entrance to Vancouver Harbor) made a dangerous point in this water system (several of the submerged pipes having already been broken by ships' keels). The city council therefore decided to secure an additional supply from Seymour Creek. This system is now almost completed and the following is a description of its chief features.

Seymour Creek empties into the northerly side of Burrard Inlet at a point about three miles easterly from the city. It is a beautiful clear mountain stream (except once or twice annually, when it becomes a raging torrent) and has a fall at the lower part of about 65 to 70 ft. per mi. Its drainage area is about 80 sq. mi., and its mean annual run-off about 500 sec.-ft. At the extreme low water the flow is about 80 cu. ft. per sec. At its source is a lake of from 400 to 500 acres, at an elevation of 3,200 ft. above sea level. In this neighborhood there are also two glaciers which help to maintain the supply of water during the summer months.

The water-works intake is located seven miles up from the mouth of the stream and has an elevation of 465 ft. above sea level. Owing to the large amount of boulders, gravel and finer sediment, which the creek carries down at freshet times, it was necessary to design the intake so that it would not become completely choked up at such times, and means had also to be provided to prevent the finer sediment entering the pipe.

*Of Harmon & Burwell, Engineers, Vancouver, B. C.

The intake is formed by a hewn cedar crib, with rock filling, made 13 ft. in height. There are two openings, each 5 ft. in width, and on the face of each opening there is placed an oak rack, set in an iron frame. The water enters the intake at right angles to the direction of the stream, the faces of the racks being parallel with the stream. This allows boulders and the most of the heavy sediment carried down by freshets to be swept away, as the current of the stream is stronger than the current of water entering the intake.

SEYMOUR CREEK CANYON, ABOVE VANCOUVER, B. C.
(A Water-supply Main was Laid and a Road Built along this Stream.)

About 50 ft. below the intake a low weir extends across the creek. This is composed of large broken rocks containing about ⅓ cu. yd. each, which were hauled in place with a donkey engine. This weir has only a sufficient height to keep sufficient depth of water on the intake during the extreme low-water period.

The water after passing through the racks centers an 11 × 14-ft. forebay. From here there is an open conduit 6 ft. in width, of hewn cedar cribwork. This conduit extends downstream along the bank of the creek for a distance of 300 ft. Its upper end is furnished with a 6 × 10-ft. headgate. At the lower end of the open conduit is placed a scour gate, discharging into the creek, its duty being to flush out the sediment which may enter the intake and deposit itself along the flume.

Just below here are located two sediment tanks (Figs. 1 and 2) designed to separate the finer sediment and floating matter from the water and prevent it from entering the pipe. These tanks are built of 6 × 12-in. sawn cedar timbers, the sticks all being placed flatwise and drift-bolted together, with frequent tie sticks extending into the bank. Each tank is 20 × 100 ft. in plan, by 6 ft. deep, and is lined with 3 ins. of concrete, fastened on the sides with expanded metal, spiked to the timber walls.

The floors of the tanks were made by first covering the ground (which consists of a compact mass of boulders and gravel) with expanded metal. This was fastened with numerous ⅝-in. anchor bolts, driven down in between the boulders, after which 3 ins. of concrete was floated through and over the whole. The object of the anchor bolts was to withstand the upward pressure which occurs at extreme high water in the creek.

Each tank is supplied with a 4 × 5-ft. inlet gate. There is also an outlet gate of the same dimensions at the lower end, which admits the water to the supply main leading to the city.

A few feet in front of the lower gates are placed two rows of screens, extending across the entire width of both the tanks. There are 16 screens in all, each 5 ft. sq. They have iron frames, backed with heavy steel wire netting, and are fitted in front with light wooden frames on which the fine screens are fastened. The screens are operated by an hydraulic hoist, which lifts a row of eight at a time, when the whole row is cleared by means of a strong jet of water. The refuse falls into a cement trough in the floor and is carried out into the creek. The water for this work is supplied from a small mountain

creek, through a 4-in. pipe, under a 125-ft. head.

Across the bottom of both tanks is placed a weir or baffle 18 ins. in height, situated about 6 ft. in front of the screens. Its duty is to prevent the sunken matter and heavier sediment from coming in contact with the screens.

Just above the weir is built a skimmer which crosses both tanks. This contrivance takes care of the overflow and carries off all floating matter.

Each tank is provided with a scour gate, 24 ins. sq., placed in its floor, by means of which a tank can be flushed out without interfering with the supply to the city.

The Supply Main.

Before constructing the supply main a good wagon road was built along the location of the pipe line. It has a maximum grade of 4½%, and a total length of seven miles. For the first 3¾ miles below the intake it is located on the northerly side of Seymour Creek. It then crosses the creek on a steel bridge and extends along the easterly side to the Second Narrows of Burrard Inlet. About half a mile below the bridge the Seymour Creek Canyon is encountered, where the creek passes through a deep cleft in the rock having almost perpendicular walls on each side. Here the road is excavated through rock along the edge of the canyon for some distance, and is very picturesque. (A view of the canyon before construction of the pipe line was begun is shown on the first page of this article.)

WOOD STAVE PIPE.—The pipe is built along the side of the road farthest away from the creek. For the first 1,000 ft. it consists of a continuous wood stave pipe, 36 ins. inside diameter. From here down to the canyon (where there is a slight summit in profile) it consists of a continuous wood stave pipe, 30 ins. inside diameter. The total length of wood pipe is 4⅓ miles.

The staves of which the pipe is built have a thickness of 2 ins. and were cut chiefly from fir timber, although some cedar (Fig. 3) was used. They were manufactured near the site of the work, as well as the lumber used in the sediment tanks and intake buildings. The city purchased a portable saw-mill and logging donkey engine for this purpose.

The price of the class of lumber required would have been $40 per 1,000 ft. B. M. at the mills in Vancouver. Haulage and handling it at least three times would have brought it up to not less than $50 per 1,000 ft., on the line. The actual cost of the lumber used in the pipe, including the cost of the saw-mill, was $28.50 per 1,000 ft., making a considerable saving in this respect.

The wood pipe is supplied with two 30-in. gate valves; one placed about one and a half miles below the intake and the other about three miles below. They were placed in these positions, partly for use in case of emergency and partly to facilitate the construction of the pipe. The pipe in one place will be subjected to a pressure due to a static head of 210 ft., and this part (which is near the bridge) has the steel bands spaced 1¾ ins. c. to c. The bands ¼-in. in diameter, fitted with forged steel [illegible] oes, and have an average of 3¾ ins. c. to c.

BRIDGE CROSSING.—The cross[illegible] of the bridge is made with a 32-in. cont[illegible]ous steel riveted pipe, with bends and special connections for wooden pipe at the both ends. It is furnished with a 6-in. blow-off at the center, and rests upon the floor-beams of the bridge. The water-tight connections between this steel pipe and the wooden pipes are made with ordinary lead joints (Fig. 4). Where the pipe line crosses ravines or small hillside creeks it is supported on substantial cedar trestles, and is enclosed in cedar cribwork filled in with sand and gravel.

In places where it is thought there might be danger from fires, the pipe line is supplied with

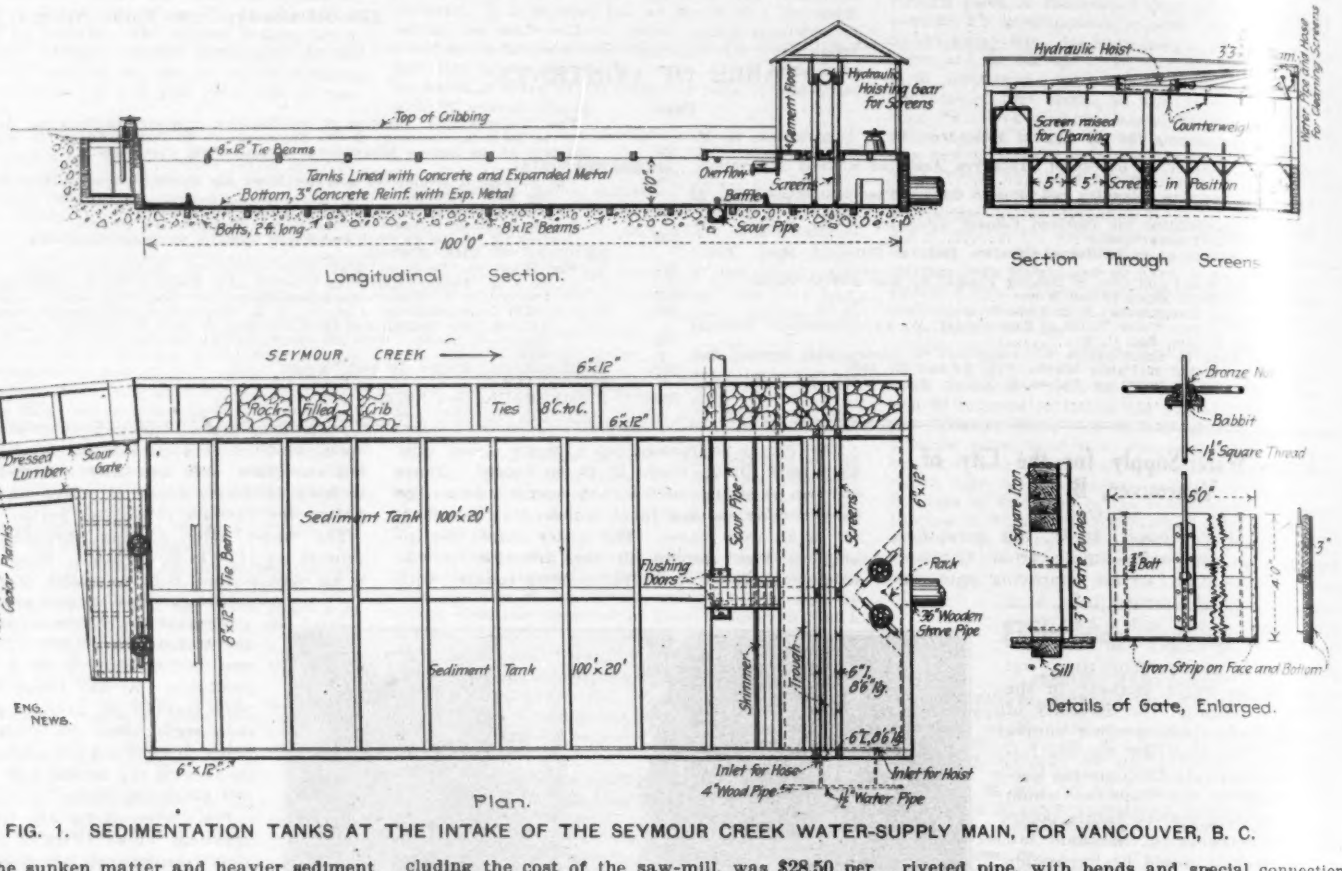


FIG. 1. SEDIMENTATION TANKS AT THE INTAKE OF THE SEYMOUR CREEK WATER-SUPPLY MAIN, FOR VANCOUVER, B. C.

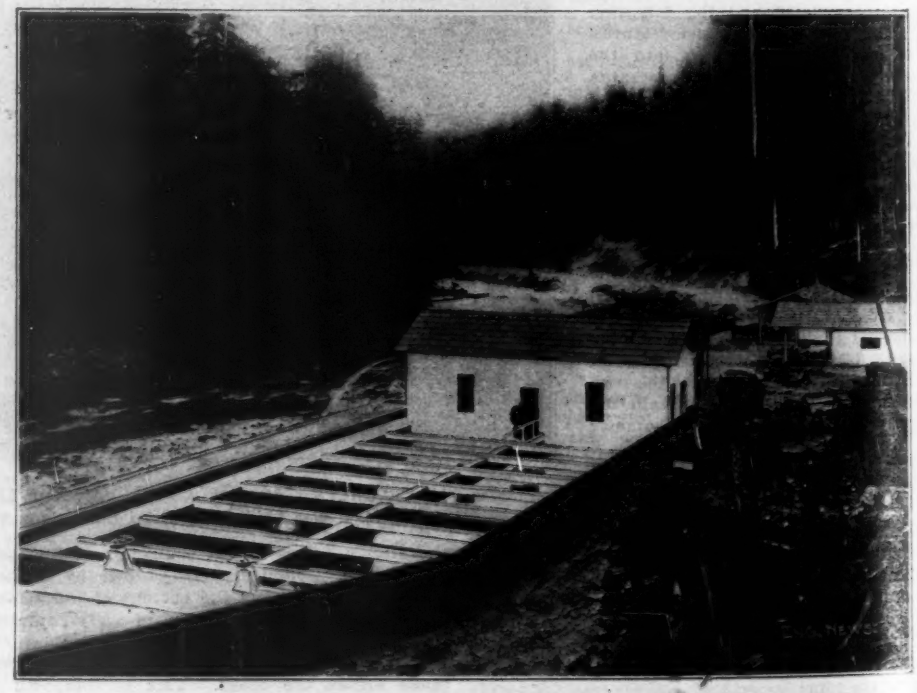


FIG. 2. VIEW OF SEDIMENTATION TANKS AT INTAKE, VANCOUVER WATER-SUPPLY

2-in. globe valves with a length of hose and a nozzle in each place, enclosed in a small house.

WELDED STEEL PIPE.—From the canyon down to the Second Narrows the pipe line is

Fig. 3. Sawing Down a Cedar for Staves for the New Water-Supply Main, Vancouver, B. C.

constructed with 24-in. lap-welded steel pipe. The shell of the pipe has a thickness of 5/16-in. (being the thinnest plate with which this kind of pipe of the above diameter is built). It is made in about 19-ft. lengths and known as "Stewart's Patent Inserted Joint" lap-welded steel pipe, and cost $3.80 per ft., delivered at Vancouver.

At the upper end it is supplied with a gate valve and a 6-in. blow-off. At the Narrows it connects with the two 18-in. submerged mains by means of a Y special. It is here supplied with a 6-in. blow-off, placed within a concrete well, which also encloses the Y and two 18-in. gate valves. The ground here is covered with tidal water at times.

SUBMERGED MAINS.—The total distance across the Second Narrows is 2,600 ft., but only about 1,000 ft. of the channel is deep water, the rest being tidal flats uncovered at low water.

The channel has a depth in the central portion of 85 ft. at low water. In this portion there are used two 18-in. flexible cast-iron pipes, built in lengths of 9 ft., with a 1½-in. shell. Each pipe length weighs 3,300 lbs. and each joint is capable of a deflection of 19°. The pipe is of the ball and socket type. The ball is formed by running lead into the joint after the pipe has been placed together.

The shore connections, amounting to 1,600 ft., are made partly of steel and partly of ordinary cast-iron pipes.

The most interesting feature in connection with the submerged mains was the placing of the flexible pipes along the bottom of the deep channel.* This was accomplished by first building a wooden trough or shute on the tidal flat at the northerly shore, directly in line with the crossing, and extending out to the edge of the deep channel. The shute was made of 3 × 12-in. lumber, supported on trestles, and of a length equal to that of the flexible main. It was well greased on the inside, after which the pipes were placed in and joined together, the bell ends each resting on a short board forming a sort of sled used to keep the pipes in place and to reduce the friction in sliding them along.

A 1½-in. steel cable was then drawn through the pipe and fastened on to eye-bolts at each end, made of 2-in. Norway iron, and about 8 ft. in length. These passed through cast-iron caps placed at each end of the pipe. The rear bolt was threaded for about 6 ft. and provided with a large nut by which the cable inside of the pipe was made taut. The front end cap was provided with a stuffing box, to permit the movement of the eye-bolt outward as the strain came on the inside cable, without admitting water into the pipe.

Three 1½-in. steel hauling cables were then fastened to the pipe. One was fastened to the pipe about one-third the distance back from the front end, one at the front end and the other was fastened to the above-mentioned eye-bolt.

As the Canadian Pacific Railway passes along the southerly shore of the Narrows, close to the water's edge, a bridge had to be erected over the track to prevent interference with traffic. The cables were carried over on top of this bridge, which was built on a slope of about 15°, owing to the high bank to the south of the track.

The platform was extended up-hill to a large spruce stump, which was used as the chief anchor for handling the pipe. At the lower end of the platform, which was 85 ft. in length, was placed a wooden roller over which the hauling cables passed.

The hauling was performed by means of five capstans operated with horses (Fig. 5). These were capable, with the blocks and tackle used, of putting a strain of 180 tons on the hauling cables.

In hauling the several 12-in. mains across the First Narrows, in the Capilano system, it was noticed that by the time the ends of the mains were landed on the south shore, the pipes were always full of water, caused by leaks at the numerous joints. This added to the weight and made the hauling more difficult, especially as the last part of the haul was up a steep hill.

The new main being much heavier than any of the prior ones hauled, it was decided to take no chances in this respect. Accordingly an air compressor was used and kept a continual pressure of from 50 to 60 lbs. in the pipe during the whole time that it was being hauled. The hauling of the flexible pipe was done by day labor, under the direction of Mr. Maddison, Superintendent of Water-Works, who had charge of the hauling of the submerged mains previously placed in the Capilano system.

The conduit from the Second Narrows to the city, where it connects with the Capilano system (a distance of about three miles) is a 24-in. lap-welded steel pipe, with the exception noted below.

The connection with the submerged pipe here is made by means of a Y, the same as on the north shore, but in addition to the two 18-in. gate valves there are two 18-in. check valves bolted to the gate valves. The pipe here passes under the railway tracks in a concrete-lined tunnel, in which is placed a special steel riveted pipe, with the necessary T and bends, all riveted together and resting in concrete saddles and concrete backings at the bends.

The pipe line, after passing through the tunnel, follows along the railway right-of-way for a distance of about half a mile (owing to the precipitous nature of the ground adjoining the railway). In accordance with an agreement with the railway company, this portion is made of ⅝-in. steel plates.

Only one submerged main has been laid. The second will be placed as soon as possible.

The total length of the supply main from the intake to where it at present connects with the Capilano system in the city is about 10½ miles, and the capacity of the system is about 9,000,000 gals. per day, or about equal to that of the present Capilano system.

Cost Data.

The wagon road along Seymour Creek was built by contract at a cost of $44,500. The work contained some very heavy side-hill cuttings and a considerable quantity of rock work.

The pipe trench for most of its length was excavated through a compact mass of large boulders and gravel, deposited by glacial action. That portion along the edge of the canyon was excavated through granite rock.

The trench for the wooden pipe (4 ft. in depth by 5 ft. in width) was performed by contract, the price being 49 cts. per lin. ft. The rock work being paid for per cubic yard brought the average cost of this trench up to 73 cts. per lin. ft.

FIG. 4. JUNCTION OF WOOD STAVE AND CAST-IRON PIPE, VANCOUVER WATER-SUPPLY MAIN.

The building of the wooden pipe was done by contract, at 39 cts. per lin. ft., the city supplying the materials.

The cost of the various parts of the work and of the entire job follows:

*Eng. News, May 14, 1908, p. 525.

COST OF WOOD STAVE PIPE.

	Per lin. ft.
Excavation of trench (contract)	$0.73
Building pipe	.89
Steel bands, including haulage	1.38
Lumber, including haulage	.65
Tongues, including haulage	.02
Paint for bands, including haulage	.02
Inspection	.01
Back filling over pipe (day labor)	.25
Total	$3.45

COST OF THE STEEL PIPE.

Excavating trench (day labor)	$0.85
Steel pipe	3.80
Laying and making joints, including lead	.23
Backfilling	.25
Haulage of steel pipes (day labor)	.07
Total	$5.20

FIG. 5. CAPSTANS FOR HAULING SUBMERGED WATER MAIN, VANCOUVER, B. C.

SUMMARY OF THE COST OF THE WHOLE WORK PERFORMED.

North Side of Burrard Inlet:	
Wagon road (contract)	$44,500
Wharf and approach at Narrows (contract)	6,000
Steel bridge	7,000
Warehouse and camp buildings	1,500
Intake and sediment tanks, including lumber, screens, gates, building complete (day labor)	19,500
Wooden stave pipe line	78,500
Steel pipe line (day labor)	76,500
Gate Valves, special steel pipe, bends, air-valves, etc.	3,500
Trestles and culverts (day labor)	3,500
Repair work to road, cutting out slides and corduroy work (day labor)	3,500
Protection work to pipe line, riprap and crib work (day labor)	5,500
Telephone line	1,000
Portable saw-mill	6,000
Logging donkey engine	3,000
Rough lumber in stock	9,000
Teaming	1,000
Total	$270,000
Submerged Main:	
Flexible c.-i. pipe, 1,000 ft.	$8,500
Hauling flexible pipe (day labor)	4,000
1,600 ft. steel and c.-i. pipe (shore connection)	7,500
Laying pipe and making shore connections, including delivery from city of all pipes	1,000
Gate valves and specials	2,500
Lumber and tools	500
Protection work, riprap and concreting	1,000
Lead	2,000
Total cost	$27,000
South Side of Burrard Inlet:	
Tunnel under railway track, concrete lined, with 40-ft. shaft	$2,000
Special steel-riveted pipe with concrete saddles and anchoring	2,000
Steel main to city connecting with Capilano System, complete	86,500
Total	$91,000
This brings the cost of the Seymour Creek System at the present date up to	$388,000
For engineering and superintendence	11,000
Total	$399,000

This amount does not include the cost of the land purchased for reservoir sites, foreshore land, pipe line right-of-way, and legal expenses. The cost of ordinary labor varied from $2.80 to $3 per day of 10 hours, regulated by the city council.

The city of Vancouver has a record on Capilano Creek for 1,500 B. C. miner's inches,* and one on Seymour Creek for 1,400, this will be sufficient to supply a population of about 400,000. The combined water systems at present developed, it is estimated, will supply a population of 180,000.

The above-described water system was designed by the writer, who also personally supervised its entire construction.

*A miners' inch in British Columbia is 1.68 cu. ft. per min.

Origin and Work of the Bureau of Explosives, American Railway Association.*

By Col. B. W. DUNN.

In April, 1905, Mr. James McCrea, now President of the Pennsylvania Railroad Co., and then Vice-President of the lines west of Pittsburg, advocated before the American Railway Association the appointment of a Committee to prepare a set of regulations to promote the safe transportation of explosives. For more than 15 years the Pennsylvania Railroad, whose traffic in dangerous articles exceeded many times that of any other road, had struggled by individual effort to decrease the chances in favor of the occurrence of fires and explosions on its property. These efforts had not prevented serious disasters, including explosions at King's Mills, Forest, Crestline, Redstone Junction and Greenwood, the net results of which were 13 people killed, 25 injured and a financial loss to the company that exceeded $300,000. The necessity for some concerted action by all roads was apparent. No amount of care can prevent the occasional destruction, always promised, by explosives not in proper condition for transportation. Of what avail, if a road by individual action secures this proper condition for all shipments originating on its line and accepts at junction points shipments prepared and forwarded with a reckless disregard of precautions? It is also true that no matter how friendly their personal and official relations, the traffic representatives of railroads are, and should be, constantly influenced by healthy competition. Regulations to promote safety necessarily cause restrictions on the practice of a shipper, restrictions that are generally unwelcome to him and sufficient to bring his custom to the soliciting freight agent who is able and willing to cancel them. To secure the shipper's consent to restrictions, it is primarily necessary to convince him that they will apply with equal force to his competitor situated on another transportation line. The enforcement of proper regulations also means the expenditure of large aggregate amounts of money by carriers and shippers, a burden which cannot be placed readily where it belongs,—on the consumer.

The appointment of a Committee on Transportation of Explosives to prepare and present to the American Railway Association at its meeting in October, 1905, a set of regulations for the transportation of explosives in order that after approval by the association, these regulations might be recommended to its members for individual adoption and enforcement, was approved. While the personnel of this Committee was still under consideration, one of the most disastrous explosions in the history of transportation by rail in the United States occurred at Harrisburg, Pa., May 11, 1905. Its net results eclipsed the aggregates already mentioned since 20 lives were sacrificed and the financial loss exceeded $500,000.

During the summer of 1905 the Committee on Transportation of Explosives, under the Chairmanship of Mr. McCrea, worked diligently and effectively in the preparation of regulations. It had the use of the exceptional knowledge and experience of Dr. Charles B. Dudley, Chemist, Pennsylvania Railroad, member of the Committee, and now President of the Bureau; it employed additional civilian experts on explosives and consulted experts from the Army and Navy Bureaus of Ordnance.

Immediately after the Harrisburg accident, the Pennsylvania Railroad put a competent man on duty as Inspector to promote the education of railway employees and shippers in the requirements of the regulations of that line for the transportation [illegible] check their violations of them. [illegible] cided to put this Inspector on duty [illegible] the Bureau of Explosives. The Ins[illegible] demonstrated the necessity for his [illegible] sized the self-evident fact that reg[illegible] force themselves.

The regulations proposed by the [illegible] proved by the Association in October [illegible] promptly thereafter by practically a[illegible] This uniform adoption and publica[illegible] essential as it was, did not produce [illegible] in the handling of shipments of ex[illegible] lustrated by an extreme case in th[illegible] Inspectors some two years later. [illegible] received, in due course, a copy of [illegible] road prescribing the regulations, wa[illegible] first inspection. Did he have a copy [illegible] The agent was not quite sure. It d[illegible] on whether this particular circular wa[illegible] soft enough to use in cleaning lamp[illegible] it had probably been expended for th[illegible] not, it might be in a box where he ke[illegible] lars that he had never found time to [illegible]

In October, 1906, a year after adoption and publication of the regulations by its members, the Association decided that some common agent of all the roads was necessary for the uniform enforcement of these regulations; and it approved a Constitution and By-Laws for a Bureau for the Safe Transportation of Explosives and Other Dangerous Articles, the preparation of which had been authorized in April, 1906.

Membership in the Bureau was optional and it was not until over seven months later that practical work was started by opening the office of the Chief Inspector in New York City. At the present time the Bureau membership comprises 158 companies operating 202,186 miles. Of the 155 members of the Association not yet enrolled as voluntary members of the Bureau, only 9 operate more than 1,000 miles of road, 4 of which are located in Canada and 2 in Mexico.

COOPERATION OF MANUFACTURERS.—The manufacturers of explosives had not complied willingly with the regulations of individual roads and the principal cause for their opposition was a fear that their competitors on other lines might avoid the expense of a more careful preparation of their shipments and thus secure a trade advantage. A general conference, invited by the Bureau in November, 1907, was attended by a majority of the manufacturers. The situation was thoroughly and frankly discussed to indicate the reforms needed in the interests of safety. It was pointed out, among other things, that the cans used for shipping black powder were weak and that loose powder, the first step toward disaster, was being found too frequently on the floors of cars in transit; dynamite was being produced with unsatisfactory absorbents that allowed liquid nitroglycerin to escape from cartridges and packing cases; packages of explosives were not being properly loaded and stayed in cars. Among the reforms acknowledged as due from the railroads were: more careful and intelligent inspection of packages to detect their defects when offered for shipment; more careful loading and staying of less than carload shipments; better selection and preparation of cars for carrying dangerous explosives; more careful handling and more frequent inspection of these cars en route.

The cooperation promised by the manufacturers at this conference has been realized. At the suggestion of the Chief Inspector, they appointed a Committee to consult with him from time to time on matters of mutual interest as they might arise. No obligation to follow the advice of this Committee was assumed by the Bureau; but it was promised by the Chief Inspector that no radical changes in regulations would be made without hearing and considering the opinions of manufacturers. One important by-product of this conference was the establishment of better relations between some of the competing manufacturers who united for the first time in striving for a common end.

PROPER LOADING AND STAYING.—The Bureau soon appreciated the difficulty involved in the uniform enforcement of a general but indefinite requirement of the regulations that packages of dangerous explosives must be loaded and stayed properly to prevent injury to them during transit. When our inspectors were asked "What is the best method for doing this?" they had to give individual opinions or answer "Use your best judgment; you are supposed to know." Having established cooperative relations with the manufacturers, the Chief Inspector convened their Conference Committee to discuss loading and staying, and asked them to bring drawings, photographs and descriptions, to illustrate the methods followed at their various plants. This conference developed the striking fact that no uniformity in these methods existed even at the different plants of the same company. Each superintendent, or loading foreman, was allowed to use his own judgment. After compiling the best features of all methods and developing them by further study, combined with actual tests under service conditions, the Bureau prepared and distributed to

*Extracts from a paper read before the New York Railroad Club, Feb. 19, 1909, under the title "The American Railway Association's Bureau for the Safe Transportation of Explosives and Other Dangerous Articles."

all factories of exp[illegible]ives a pamphlet with detailed drawings and photogra[illegible] to illustrate the best method that could be devised [illegible] the knowledge available at that time. We now h[illegible] uniform method in force at these important loading[illegible]nts and are securing an increase in safety combin[illegible] with a decrease in expenditure of labor and materi[illegible] Reports from destinations, received through the court[illegible] of the manufacturers, show a gratifying decrease in[illegible] number of damaged packages. Not content with th[illegible]rtial solution, and through assistance offered by t[illegible]pioneer in this general movement to promote safe tr[illegible]portation, the Pennsylvania R. R., the Bureau inaug[illegible]ted, at Altoona, Pa., more extensive experiments.

In all of the t[illegible] made heretofore of car impacts, so far as known to the writer, only the energies absorbed, in foot-pounds, have been measured. The desirability of obtaining measure[illegible] of the intensities of forces developed by these impacts is evident, since injuries to the cars and to their ladings depend primarily upon them.

So long as the energy does not exceed that which can be absorbed by the springs and the friction draft gear, we have, from the calibration of this gear, a fair knowledge of the maximum stresses developed; but any additional energy must be absorbed by the elastic, or permanent deformation of the car frames.

To obtain the most accurate measures of the accelerating, or retarding, force generated by coupling shocks, a good time space record for the resulting movement of the car should be obtained. The most practical and efficient method for doing this involves the use of photography and the making of tests at night. (See Construction Notes Nos. 71 and 74, Ordnance Department, U. S. Army.) The labor and the cost involved in applying this research method to the numerous tests that would be necessary to investigate an extended series of impacts, at various speeds and under varying conditions as to numbers of cars at rest and in motion, would be comparatively great; and for this reason a method had to be devised to obtain approximate measures more directly.

Conceive a cylinder rigidly attached to the longitudinal floor beams of the car, its axis parallel to the floor and to the track. One end of the cylinder is closed by a thin metal diaphragm and into the top of the cylinder is screwed a delicate pressure gage. Pipe connections permit forcing water into the cylinder under an adjustable head until the diaphragm is deflected outward slightly and the gage shows the desired initial pressure. A known weight of cylindrical shape is suspended from the roof of the car so that one face rests in light contact with the diaphragm and the other in contact with an adjustable back stop, also rigidly secured to the car frame. Means are provided for measuring speed in miles per hour, at the instant of impact.

The pressure required to accelerate, or retard, the suspended weight is communicated to it through the liquid and the diaphragm, and is registered by the gage. The slight change in interior volume, represented by movement of the piston of the gage, is counterbalanced by an inward deflection of the diaphragm of only a few thousandths of an inch. The path over which the work is done on the suspended weight is, therefore, practically identical with that for the entire car, and the maximum stress per unit of weight at any instant, applied to the car, will also be applied to the weight. The same force, diminished by the friction on the car floor, would be exerted on each unit of weight in the lading, to produce relative movement of the lading along the car floor. This force, multiplied by the number of units of weight in the lading and corrected for friction, represents the total resistance that must be offered by the means provided for staying the packages.

Preliminary tests with this apparatus have been made, but at this date the results are not available for complete discussion. It can be stated with approximate accuracy, however, that when a draft of four loaded coal cars collides, at about six miles per hour, with a single car whose brakes are not set, a maximum accelerating force of about 18 lbs. for each pound of weight is developed to move the lading along the floor of the car. The correction for friction will vary with condition of the floor, and the material and shape of the packages. For one set of conditions, the measured coefficient of friction was about 0.4. While a single box of dynamite, weighing 58 lbs. and moving at a speed of 6 mi. per hr., would thus slide under friction only 3 ft. along the floor, it would require a maximum force of about 1,000 lbs. to keep it from sliding at all. If one could be sure of having the 3 ft. available for it to slide without striking the end of the car, or some other package, it would be better for the package to acquire its change of velocity in this way. With this relatively long path, the constant force exerted on the box would be only about 23 lbs., to be compared with the maximum of 1,000 lbs. necessary to restrict the path of the box to that of the car. We have no data as yet to tell us how long these maximum forces act, but we know the time to be very short, and this explains the observed fact that packages do resist dynamic forces that exceed their static strength.

The importance to railway operators of investigations to determine the forces that derange packages of freight cannot be overestimated. It will become apparent when we examine the amounts paid monthly for these damages. The writer has been informed that one line operating between California and Chicago pays an average of $5,000 per month for damages to shipments of fruit. In the case of fruit shipments, the value of the package is the maximum risk; for shipments of explosives the rupture of a package may readily lead to an explosion the total cost of which has been known to exceed $500,000. A knowledge of these forces must precede the adoption of practical remedies for preventing the damage. If effective staying cannot be provided in all cases, the necessity for caution in coupling cars will be emphasized.

EDUCATION OF SHIPPERS AND EMPLOYEES.—A military force on parade has a complete system to check delinquencies. The corporal checks the private, the sergeant the corporal, the lieutenant the sergeant, and so on. In extended battle formation, however, dependence must be placed on individual initiative and loyalty. Our army of railway employees is always in battle formation; and in fighting for the safe transportation of dangerous articles the employee's defence, for himself and those dependent on him, rests solely on his knowledge of his enemy and of rules based upon the knowledge of others. Our first step must be to create a desire on his part to acquire that knowledge, to interest him and to impress him with a just appreciation of his responsibility. A prompt appreciation of this responsibility is always produced by a disastrous explosion on a railroad. The uneasiness of the General Manager is then transmitted to the lowest subordinate whose previous indifference gives place to an impatient desire to know how he can avoid being in any way responsible for future loss of life.

The Bureau has undertaken a systematic campaign of education to arouse in a less expensive way, and then to satisfy, this thirst for knowledge. By well selected lantern slide illustrations, the power of explosives to destroy is shown and the unfortunate results of previous explosions are depicted. The origin, growth and necessity for regulations are explained that employees may become advocates instead of critics of the restrictions imposed by them. Whenever possible, shippers of dangerous articles are included in the audiences. Each convert made in this way becomes a new center for the distribution of interest and information.

A competent representative of the Bureau is engaged almost constantly in delivering these more formal educational lectures and each of the local inspectors attends frequently, on the railway divisions to which he is accredited, regular and special meetings of station agents and other employees. The interest evinced by prominent railway employees in these talks or lectures is shown by the fact that in one audience the voluntary attendance exceeded 1,300, in another 1,000, and in several others approximated 500. Requests for the lectures have been received, and honored, from Railway Clubs, Chambers of Commerce, Freight Agents' Association, a State Railway Commission and the National Association of Railway Commissioners.

DELEGATION OF AUTHORITY.—For effective action, in some emergencies, the authority granted by the Constitution and By-Laws of the Bureau to stop dangerous shipments, must be exercised. A constant effort has been made, however, to confine the Bureau to the role of an advisory expert. In time its agents may acquire by their work the confidence of railway officials, and be recognized, not as foreigners, but as members of the families of the roads over which they operate. The Chief Inspector should be regarded as a member of the technical staff of every member of the Bureau.

In a few instances only has it been necessary to request members to support the Bureau by placing embargoes on dangerous shipments offered by delinquent shippers. In many cases the shippers have been willing to cooperate with us by placing the necessary embargoes upon their own shipments upon information received from the Bureau.

The object is to obtain results by the most direct methods with the least expenditure of energy and with the least disturbance of normal conditions. A local inspector is required to correct erroneous practices by his own efforts, if practicable. As a rule, the detection of the error, followed by education of the party responsible, is sufficient. If not, a prompt support by the Division Superintendent will accomplish the purpose. In some cases, the aid of the General Superintendent, or of the General Manager has to be requested through the Chief Inspector. For information, all violations of regulations are reported to the Chief Inspector and to railway officials.

LEGALITY OF THE RULES.—The legality of the rules and the penalties that can be enforced for wilful violations of them should be understood by all concerned. The Federal Law of May 30, 1908, is unusual and it illustrates a modern tendency to delegate legislative authority to commissions. The promulgation by Congress in 1866 of a rule for the packing of explosives for transportation had proved a failure; and this act of 1908 transfers to the Interstate Commerce Commission legislative authority to prescribe details. This Commission confines its direct action to explosives, but finds it necessary to give general directions to the common carrier which require him to go still further and add rules of his own for handling both explosives and inflammables. The rules thus added, until pronounced inefficient, unreasonable or unnecessary, by a court of competent jurisdiction, are also the law of the land, and wilful violators of them are subject to the penalties prescribed in the Act. We thus find a graded exercise of legislative authority by Congress, the Commission and the Common Carrier, each having the power, under general limitations and subject to judicial approval, to change its own rules. An official who, for any improper purpose, such as diversion of traffic, directs his subordinates to violate, or permits the wilful violation of, any one of these properly promulgated rules is an enemy of the public welfare and is subject to prosecution and punishment. Imagine the predicament of such an official if loss of life could be shown to result directly from his action. For much less reason a prominent official has had to answer at the bar of justice to a charge of homicide.

POSSIBLE DEVELOPMENT.—For years, railway employes and officials have been organizing with great benefit to their varied interests. I doubt whether any of you could prepare, without some research, a list of all of these associations. Unfortunately, some of them exercise independently very important functions, and their fields of influence overlap, with resulting confusion, if not actual conflict of rules. Traffic officials find it necessary to prescribe rules for packing certain articles in fixing their freight classification; the Bureau of Explosives considers different rules necessary to secure safety and the shippers' confusion is excusable.

Absence of useful combinations means a waste of energy. Our railway lines are traversed by scores of inspectors whose general usefulness could be vastly increased by proper coordination of their education and duties. We have seen in the growing importance and usefulness of the Committee on Car Efficiency how a combination of interests can increase the efficiency of equipment; and it is predicted that a combination to increase the efficiency of our educational and inspection service will be effected eventually by the organization of what may be called a "Bureau of Enforcement" or a "General Inspection Bureau" whose agents will act as scouts for all operating officials to keep them informed of the actual conditions on their lines and to assist them in perfecting and enforcing all of their rules.

CHARLES B. DUDLEY.*—My own connection with the transportation of explosives is now 25 years old. I remember well the first thing which led up to the Bureau of Explosives, described in the Colonel's paper, and which he has illustrated to you this evening. It was in 1883, I think, that the Repauno Chemical Company, a branch of the Duponts, situated on the east side of the Delaware River, about opposite Wilmington, first began to manufacture high explosives. The industry was very new at that time and none of us knew very much about them—even those who were manufacturing them. They had contracts for explosives to be delivered. The railroads did not carry explosives, at least they did not know it if they did, and the high explosive company's products were largely carried by water. A freeze-up in the Delaware River put an embargo on their transportation and the representatives of this factory went to Mr. Cassatt, who was at that time Third Vice-President of the Pennsylvania R. R., in charge of traffic, asking for help. He said to them: "I am afraid of the stuff—suppose a carload of this stuff going through Philadelphia or Harrisburg or Pittsburg should be exploded by some means or other?" They tried to persuade him that the stuff was as safe to carry as sugar. So after a few moments deliberation, Mr. Cassatt said to them: "I will take all you offer for two weeks; meanwhile I will have an investigation made to decide on a line of policy in regard to this new material." So the papers were sent to Altoona to Mr. T. N. Ely, with instructions to have an investigation made and to report giving reasons and why, what should be done in regard to carrying explosives. The matter fell to me. I went down to Repauno to see how the stuff was made. I remained a couple of days and a number of experiments were made. Among the experiments the following: A box of 50% dynamite was taken up on a water tower about 30 ft. high, while the superintendent and myself were at the bottom. One of the boys in the employ of the company was at the top of the water tower, and he had also an armful of loose cartridges. He was to throw both the box and the cartridges off the top of the water tower. I said to the superintendent, "Where are you going to stand?" He said, "I will stand right here. There is no danger." I said, "If there is no objection, I will stand over here behind this pile of rails." The box was pushed off the tower on to the stones below. The result was that the box was broken open, but no explosion took place, and then the boy took the cartridges one at a time and threw them down to the rocks. The object of this was to show that certain shocks are not hazardous with a well made nitroglycerin powder.

There were a number of other tests made. The result

*Discussion of Col. Dunn's paper. Dr. Dudley is Chemist of the Pennsylvania R. R. at the company's laboratory at Altoona, Pa.

of the investigation was that it would be wise to carry high explosives since they were essential for the industries of the country, but they should be carried under proper regulations. That report went to Philadelphia, and forthwith it came back to me with the request: "Please prepare the regulations," which I had not calculated upon. Anyhow I prepared the first regulations which covered less than an ordinary letter size sheet. They were very simple, and in the light of our present knowledge almost ridiculous, yet they were the beginning, you might say the inception of the Bureau of Explosives.

At that time, if I remember rightly, there were only three nitroglycerin factories in the United States. One at Drakesville, N. J.; one at Repauno, and one on the Pacific Coast.

The explosive regulations were revised from time to time as we got more knowledge. They were adopted by a number of the largest railroads of the United States. In the course of time the explosive industry began to grow. More factories started up. It does not take much money to start a nitroglycerin factory. All you need is some ground and three or four thousand dollars and you may start a nice factory. As the industry grew the regulations were revised—and an attempt was made to keep them up to date as well as we could. Up to this time in the enforcement of the regulations reliance had been placed simply on the trainmen and the station agents. The method consisted simply in sending to the station agent where the material was loaded, and to various officers, for the use of the men, a printed copy of the regulations, the expectation being that they would do as the regulations required. But presently we found that regulations do not enforce themselves. We had an explosion at Crestline some six or eight years ago of high explosive made at Emporium. So, I went to Emporium to find out what was the trouble. I found an extremely lax state of affairs. The agent told me he had not been at the loading platform for two years. The superintendent of the factory said that he had heard that the Pennsylvania R. R. had regulations for the transportation of explosives, but he had never seen a copy. Well, the matter became so serious that four or five years ago the matter was taken up by the American Railway Association, where it should have been placed fifteen or twenty years ago.

A movement of this kind essentially requires cooperation among all the railroads, and the matter became so serious that some radical measures had to be adopted. The dreadful explosion at Harrisburg in 1907 caused the railroads to realize that these regulations should be enforced in some better manner. Nearly all the railroads had adopted the regulations prepared by the American Railroad Association, but again we found that regulations do not enforce themselves, and agitation was started looking toward establishing this Bureau. The Bureau is simply a voluntary organization of the railroad companies to enforce these regulations, and the paper which the Colonel has written for you tells you something about the work of the Bureau.

I will only tell you one more thing. A year or two ago we found strangely enough in the revised Statutes of the United States a statute some forty years old which required the packing of dynamite in such a way that every expert to-day will tell you is more hazardous to transport than the present custom. It also required an absurdity, that is, that dynamite should be packed in metal boxes and outside of that should be a covering of plaster of Paris, or some other substance, which would not explode when saturated with nitroglycerin. But there is no such substance known. A very good high explosive can be made by saturating plaster of Paris with nitroglycerin. That statute had been a dead letter for forty years on the statute books of the United States, but there was connected with it a fine of $2,000 for every violation, half of the money to go to the informer. If anybody had brought an action under this statute against any large railroad they might have made a pretty nice sum of money. We succeeded last winter in getting that statute repealed and in place of it a law passed putting the transportation of explosives on a legal basis, and we now feel that we are in a position to go ahead with a great deal more safety than we ever had in the past.

The statistics show that there are about 500,000,000 lbs. of high explosives manufactured in the United States every year, that is, taking the best figures that the Bureau can gather, up to the present time. After we have been in operation a few years we will have more positive statistics. The largest bulk of this large amount of explosives is transported by the railroads. Of course the most of it is used in mines and quarries for blasting. It is estimated by the Geological Survey that 65% of the tonnage transported by the railroads is mineral products, some of it coal, some of it iron, and other ores, but altogether making up 65% of the total tonnage of the railroads of the United States. But inasmuch as these ore products have to be gotten out by the use of explosives the railroads may consider that if it were not for explosives they would lose a large portion of their business. Again, this 500,000,000 lbs. being divided up into shipments, some of it in carload lots, and some in less than carload lots, and we find that there are about 5,000 cars with explosives on them continually in transit, and if it takes on an average ten days to make a delivery from point of shipment to destination, we have figured out that on an average there is a carload of explosive for every fifty miles of railroad throughout the United States, so that for every fifty miles of railroad that a person travels over he probably passes a car containing explosives, and every car so loaded is a source of danger. On the more busy roads the proportion, of course, is much greater.

Failures in Concrete Sidewalks and How to Correct Them.*

By L. J. RIEGLER.†

Noting the great number of failures in concrete walks and for purpose of avoiding trouble in future work, an investigation was recently made to determine the causes and, if possible, to determine whether the fault was with the materials used, the design of the walk, or with the workmanship.

A great many walks have flags warped into saucer-like shapes, as shown in Fig. 1, without any signs of cracking, which flags, unless the walk is on a grade, act as basins holding water after each rain. These warped flags occur both in walks of large area made up of a number of rows and in single flag suburban walks, flanked

FIG. 1. A TYPICAL MID-FLAG SAG IN CONCRETE SIDEWALK.

by lawns. In the latter case, however, the warping of the flags transversely to the length of street is generally greater than that along the street, and in addition, there is usually a longitudinal crack along the center of the walk, as shown in Fig. 2. Suburban walks flanked on one side by a terrace are generally the worst. A great many walks are cracked at curved corner curbs, and at the ends of walks next to the curb at cross streets, often flags in the middle of long walks buckle up, as shown in Fig. 3. In many cases the expansion in the cement walk has either pushed the curb out of line or broken it off entirely.

After a study of the subject the opinion is that these failures are seldom caused by chemical action in the cement used, but are the result of mechanical action in the concrete or foundation, or both due to poor and indifferent work during construction and due in many cases to wrong design for foundations and drainage.

In concrete walks, as usually built, the earth is excavated to 10 or 12 ins. below the finished surface and 6 or 8 ins. of cinders are laid for foundations on which the 3-in. concrete walk is laid, with a 1-in. cement covering surface. No additional drainage is provided. The result is that water enters the foundation of the walk through the lawns on either side, and at all the joints between the flags whether on suburban walks of single flags or walks of larger areas. Naturally, this moisture is grea[ter] at the sides and near the joints, where its e[ffect] is, very little reaching the center of the flag. S[ub]sequent freezing causes greater upheaval o[f] the foundation near the edges of the flag than [in] the suspended center, the flag finding bearing [on] the edges acts as a beam. The load, while [of] great, is applied continuously and simul[ta]neously, with changes in temperature, and final[ly] causes a flow of the material, resulting in depr[es]sion and permanent set. Experiments made [with] small pillars of concrete under high press[ure] have shown remarkable flow without appar[ent] damage to the concrete.* It is very probable [that] when called upon to withstand tensile stress [on] the lower side of a beam, the strength of [the] concrete in the base is practically nil for the g[rea]ter number of walks, throwing all the work on the top wearing surface which, being only 1-in. thick, could readily bend without cracking.

Another cause is the dissimilarity in density of the concrete base and the top coat or wearing surface, which causes a different ratio of expansion and contraction in the base from that in the top, and results in warping. This can more readily be appreciated when one considers the relatively poor quality of the concrete attainable in the base as compared to that in the wearing surface. Samples of concrete base taken out of old sidewalks have shown too that the concrete in the base is quite porous, and if the water gets into the foundation at the sides or the joints, there is no doubt but that this porous concrete will absorb considerable moisture which, when freezing, will cause compressive stresses in the underside which, in conjunction with the stronger top coat, could warp the flag. That the concrete base does absorb water is shown by the disintegration of the concrete base, and that the absorption, freezing, and thawing is greater near the edges and joints is shown by the greater disintegration at these points.

SUB-FOUNDATION AND DRAINAGE.—The question of perfect drainage in the sub-foundation is of utmost importance. As an illustration, in rebuilding a walk in 1907 the drainage was taken care of as shown in Fig. 4. The curb had already been provided with a broken-stone foundation which would act as a drain, and all that was necessary was to dig trenches about 10 ins. deep and of a convenient width across the sidewalk, extend to the curb, and fill with broken stone. The sidewalk having a grade the ditches were dug across obliquely, so as to take advantage of the slope. The walk at present is in good shape and quite in contrast to the walks adjacent to it and for which this provision was not made. Fig. 5 shows a section of concrete walk as speci-

*Portion of a report presented to the Pennsylvania Company.

†Engineer, Pennsylvania Company.

*See Engineering News, Nov. 2, 1905, p. [illegible].

fied by the City of Pittsburg, which provides an outlet for drainage to the curb somewhat like that on Fig. 4.

Where there is no provision made at the curb for drainage it would be well to carry same to sink holes proposed to get the water below freezing line. The sub-foundation should be an even plane exactly parallel to the proposed top surface and should not have any low places where water might collect and could not be drained. Where such places occur, they should be filled up with foundation material to an even surface. The entire sub-foundation should be compacted by ramming, which should be evenly done so as to get the same compaction at all points.

FIG. 2. A LONGITUDINAL CRACK; A COMMON FAILURE.

FOUNDATION.—Broken stone and gravel are sometimes used for foundation, but cinders are most frequently used and are preferable. The thickness of the cinder foundation required varies in the different city specifications from 4 to 12 ins. A thickness of 6 ins. is ample. In fact a greater thickness, unless deep enough to go below the freezing line, would really be detrimental, as obviously the upheaval of frozen cinders would be proportional to its thickness. Cinders that have been placed in a walk for some time before placing the cement should be picked loose and re-tamped so that the entire mass has even compaction. If some places are packed harder than others, the flag will not have an even bearing and may break. One of the causes of inferior concrete in the base is the absorption of water from the mixture before it has set by the porous foundation; therefore, it would be well to specify a thorough wetting of the foundation just before placing the concrete.

CONCRETE BASE.—There is no doubt but that concrete in the base of concrete walks generally taken is the most inferior concrete made for several reasons: The capital and equipment necessary for doing this kind of work is comparatively small, and the construction work apparently easy, the result being that many walks are put down by inexperienced contractors. The competition between such contractors has reduced the price so that good work can not be done profitably, but even with as good material and workmanship, it does not seem possible to get as good concrete in cement sidewalk base as in structures of larger volume, such as retaining walls, abutments, etc. For instance, consider the effect of tamping a thin layer of concrete, say 4 ins. thick, laid on a cinder bed. The concrete may compact a little under each blow, but a great part of the force is expended in forcing the concrete up at another place and possibly dislodging the cinder bed. This is one of the reasons why it is necessary to have the cinder bed thoroughly compacted before placing concrete, and why it is advisable to so mix the concrete and have it of such a constituency as to reduce the amount of tamping necessary. The tamping of concrete is more necessary in dry mixtures than in wet; experiments have shown that as the latter is already more dense there is less compaction due to tamping in wet concrete than in dry.

Slightly more water should be used in mixtures for concrete base than is now generally used, and thorough mixing adhered to, as well mixed concrete is more dense than poorly mixed and requires less tamping. Gravel mixtures require less tamping than stone. Within certain limits, an improvement in mixing will enhance the value of concrete more than increasing the amount of cement. The proportions of 1 cement, 2½ sand, and 5 gravel or stone, as now generally specified, are approximately correct, only a slight adjustment being necessary to meet conditions in local sands and gravels. On account of the relatively poor quality of concrete obtainable in the base of walks, it would seem to be advisable to increase the thickness of the base from 3 ins. to 4 ins. for those walks which are to be subjected to heavy traffic. The top wearing surface should be 1 in. thick.

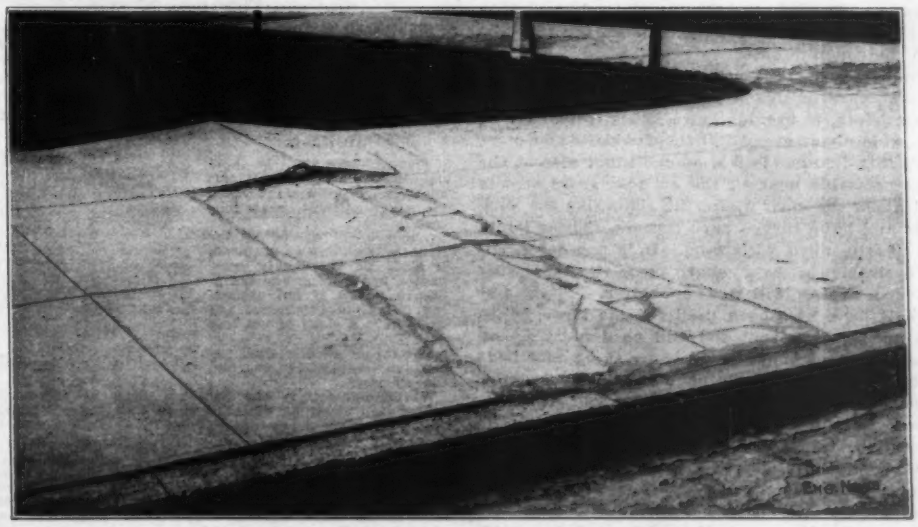


FIG. 3. A BUCKLED SLAB DUE TO EXPANSION.

TOP COAT.—A great many failures are due to a lack of bond between the top coat or wearing surface and the concrete base. In the laying of the walk, and in order to accomplish much work, the concrete base is sometimes allowed to get its initial set before applying the top coat, consequently there is little bond, the upper wearing surface becomes loose and easily breaks. If the upper surface of the base is troweled or smoothed off, the strength of the bond is reduced. It is important, therefore, to leave the base free of troweling.

Tests made have shown the expansion for neat cement is about three times as much as for a 1 to 3 mixture. It seems reasonable, therefore, to assume that the expansion or contraction in the wearing surface which is made with a 1 to 1 or 1 to 1½ mixture is greater than for the base which is 1:3, and to attribute some of the warping to this cause. It would seem then that the mixture used in the top coat should be very nearly the same proportion as that used for the mortar of the base. In other words, if the base is mixed 1:2½:5, then the wearing surface should be 1:2½; the proportion 1:1 and 1:1½ now used is too rich.

Crazing or fine cracks which appear on the surface, but have no appreciable depth, will no doubt be less frequent with less rich wearing surface. The claim may be made that a richer wearing surface will withstand wear better and perhaps it will. Very few cement walks, if any, have been worn out—nearly all fail in some other manner. Ligonier screenings, limestone screenings, and sand are used for top wearing surfaces. Most contractors, however, prefer limestone screenings to ligonier. Sand dug from some of the rivers contains some fine particles of organic matter which, after being exposed to the weather for a short time, decay, leaving small black spots on the upper surface of the walk. On this account, a walk with sand-wearing surface does not have so good appearance as one made of limestone screenings, but it is not so slippery. Where the walk to be laid is on a grade over 2%, it would be well to use a sand top coat mixture 1: 2½ in preference to screenings.

JOINTS.—When concrete walks were first laid, forms defining the blocks were used and the concrete placed in alternate blocks. When these had set the remaining spaces were filled in. This scheme made positive joints and prevented breaking of flags on account of settlement. While this is still required in some specifications the large majority of work is done in continuous sheets, the walk being cut at the joints by a knife and sledge. Some specifications require the joint to

be filled with sand and the surrounding concrete tamped, and some specifications require tar paper put into joint. After the top coat or wearing surface is put on, it is cut through over the joint in the base. The cutting is often indifferently done and sometimes the cut through the wearing surface is not directly over the cut through the base. Then if there is any settlement the top will crack in an irregular line. Water will also get in at the joint under the top coat and freeze,

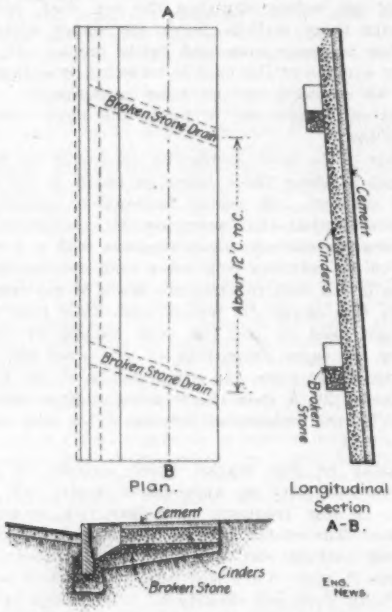


Fig 4. Details of Drains for Concrete Sidewalks.

causing it to break. The objections to laying the alternate blocks in a walk are that it is hard to get the different blocks in a true plane, the appearance, therefore, is not so good. Another objection is the increased cost and time required. It would seem that the method now most generally followed of building a continuous course and cutting up into blocks with a tool designed for that purpose is the best. The tool should be so shaped as to make the top edges of the groove firm, smooth and slightly round, and should be long enough to cut entirely through the top coat and the concrete base.

The greatest failures are from expansion and to take care of this it is well in addition to the block joints, to provide extra joints from 1 to 1½ ins. wide about every 100 ft. of walk when more than this distance is laid at one time; also at the ends of walks next to the curb at cross streets and along the curb where the sidewalks are very wide and have curved curb corners. These joints are usually filled with sand. It is not necessary or desirable to have sharp sand; sand with rounded grains will answer better. Pitch and asphalt have also been used for the large joints and answer very well and will no doubt prevent to some extent moisture reaching the cinder bed.

The size of the blocks on many walks are too large. They should be limited to about 6 × 6 ft. When the sidewalk extends from a building to the curb or in subways from the abutment to the curb or curb wall, as the case may be, the writer believes that the cement walk should not be built tight around the building, abutment, curb, or curb wall, but an open joint about 1 in. wide should be left. There is likely to be some settlement in either the building, abutment, curb, curb wall or sidewalk and irregular cracks will result.

It is believed also that some cracking is caused by the upper surface of the walk drying out fasten than the bottom, acting very much as dried mud in a river bottom, where it seems probable that the sun dries the top first, which shrinks and breaks up into small blocks. Subsequent shrinking in the lower stratum only increases the width of the cracks. For this reason, it will be well to keep the top of the walk moist for several days during dry weather. It is known that wetting the surface will also produce a whiter walk than one that is allowed to dry out quickly.

Portland cement concrete sidewalks, when properly constructed, are no doubt superior to all others. The cost of construction is not much greater than other sidewalks, so that their more extended use depends upon their permanency. It is advisable, therefore, that the best material and workmanship be used so as to get best possible results.

Standard Specifications for Portland Cement Concrete Sidewalks of the National Association of Cement Users.

In connection with the preceding article we record the standard specifications for concrete sidewalks recently adopted by the National Association of Cement Users.

Materials.

The cement shall meet the requirements of the specifications for Portland cement of the American Society for Testing Materials, and adopted by this Association (Specification No. 1), January, 1906.

Aggregates.

Fine Aggregate shall consist of sand, crushed stone, or gravel screenings, graded from fine to coarse, passing when dry a screen having ¼-in. diameter holes, shall be preferably of silicious materials, clean, coarse, free from vegetable loam or other deleterious matter, and not more than 6% shall pass a sieve having 100 meshes per linear inch.

Mortars composed of one part Portland cement and three parts fine aggregate by weight when made into briquets shall show a tensile strength of at least 70% of the strength of 1:3 mortar of the same consistency made with the same cement and standard Ottawa sand.

Coarse aggregate shall consist of inert material, graded in a size, such as crushed stone or gravel, which is retained on a screen having ¼-in. diameter holes, shall be clean, hard, durable, and free from all deleterious materials. Aggregates containing soft, flat or elongated particles, shall be excluded.

The maximum size of the coarse aggregate shall be such that it will not separate from the mortar in laying and will not prevent the concrete fully filling all parts of the forms. The size of the coarse aggregate shall be such as to pass a 1¼-in. ring.

Water shall be clean, free from oil, acid, strong alkalies, or vegetable matter.

Forms.

Forms shall be free from warp, and of sufficient strength to resist springing out of shape. All mortar and dirt shall be removed from forms that have been previously used.

The forms shall be well staked to the established lines and grades, and their upper edges shall conform with finished grade of the walk, which shall have sufficient rise from the curb to provide proper drainage; but this rise shall not exceed ⅛ in. per ft., except where such rise shall parallel the length of the walk.

All forms shall be thoroughly wetted before any material is deposited against them.

Size and Thickness of Slabs.

Slabs shall not contain more than 36 sq. ft. or have any dimension greater than 6 ft. For greater area, slabs shall be reinforced with ¼-in. rods, not more than 9 ins. apart, or other reinforcement equally as strong.

The minimum thickness of the pavement shall not be less than 4 ins.

Sub-Base.

The sub-base shall be thoroughly rammed, and all soft spots removed and replaced by some suitable hard material.

When a fill exceeding one foot in thickness is required, it shall be thoroughly compacted by flooding and tamping in layers of not exceeding 6 ins. in thickness, and shall have a slope of not less than 1 to 1½.

The top of all fills shall extend at least 12 ins. beyond the sidewalk.

While compacting, the sub-base shall be thoroughly wetted and shall be maintained in that condition until the concrete is deposited.

Base.

The concrete for the base shall be so proportioned that the cement shall overfill the voids in the fine aggregate by at least 5%, and the mortar shall overfill the voids in the coarse aggregate by at least 10%. The proportions shall not exceed one part of cement to eight parts of the fine and coarse aggregates. When the voids are not determined, the concrete shall have the proportions of one part cement, three parts fine aggregates and five parts coarse aggregates. A sack of cement (90 lbs.) shall be considered to have a volume of one cubic foot.

Mixing.

The ingredients of concrete shall be thoroughly mixed to the desired consistency, and the mixing shall continue until the cement is uniformly distributed, and the mass is uniform in color and homogeneous.

a. Measuring Proportions. Methods of measurement of the proportions of the various ingredients including the water, shall be used which will secure separate uniform measurements at all times.

b. Machine Mixing. When the conditions will permit, a machine mixer of a type which insures the proper mixing of the materials throughout the mass shall be used.

c. Hand Mixing. When it is necessary to mix by hand, the mixing shall be on a water-tigh[t] especial precautions shall be taken to tur[n] until they are homogeneous in appearan[ce]

d. Consistency. The materials shall [be] enough to produce a concrete of such a [con]sistency as will flush readily under light tamping, [but] the other hand, can be conveyed from the [mixer to the] forms without separation of the coarse a[ggregate from] the mortar.

e. Retempering. Retempering motar or [concrete, i. e.,] remixing with water after it has partially [set] shall not be permitted.

Placing of Concrete.

a. Methods. Concrete after the addition [of final] the mix shall be handled rapidly to the [concrete be] deposit, and under no circumstances shall [be] used that has partially set.

b. Freezing Weather. The concrete shall [be mixed] or deposited at a freezing temperature [unless] precautions are taken to avoid the use of [materials con]taining frost or covered with ice crystals, and [in provid]ing means to prevent the concrete from [freezing after] being placed in position and until it has [thoroughly] hardened.

Sidewalks shall be laid in such a manner [as to insure] the protection of the pavement from injury due to changes in foundations or from contraction and expansion.

Workmen shall not be permitted to walk [on freshly] laid concrete, and where sand or dust collects on the base it shall be carefully removed before the wearing surface is applied.

Wearing Surface.

The wearing course shall have a thickness of at least 1 in.

The wearing surface shall be mixed in the same manner as the mortar for the base, but the proportion one cement to two of fine aggregate, and it shall be of such consistency as will not require tamping, but will be readily floated with a straight-edge.

The wearing surface shall be spread on the base immediately after mixing, and in no case shall more than 50 minutes elapse between the time that the concrete for the base is mixed and the time that the wearing course is floated.

After being worked to an approximately true surface, the slab markings shall be made directly over the joints in the base with a tool which shall cut clear through to the base and completely separate the wearing courses of adjacent slabs.

The slabs shall be rounded on all surface edges to a radius of not less than ½-in.

When required the surface shall be troweled smooth.

The application of neat cement to the surface in order to hasten the hardening is prohibited.

On grades exceeding 5%, the surface shall be roughened. This may be done by the use of a grooving tool, toothed roller, brush, wooden float or other suitable tool; or by working coarse sand or screenings into the surface.

Where color is used it shall be incorporated uniformly and the quantity and quality shall be such as to not impair the strength of the wearing surface.

Single-Coat Work.

Single-coat work shall be composed of one part of cement, two parts of fine aggregate and three parts of coarse aggregate, and the slabs separated as provided for in the specifications for two-coat work.

The concrete shall be firmly compacted by tamping and evenly struck off and smoothed to the top of the form. Then with a suitable tool the coarser particles of the concrete shall be tamped to a depth which will permit of finishing the walk as under "Wearing Surface."

Protection and Grading.

When completed, the walk shall be kept moist and protected from traffic and the elements for at least three days.

Grading after the walks are ready for use should be on the curb side of the sidewalk, 1½ ins. lower than the sidewalk, and not less than ¼-in. to the foot fall towards the curb or gutter. On the property side of the walk the ground should be graded back at least 2 ft. and not lower than the walk; this will insure the frost throwing the walk alike on both sides.

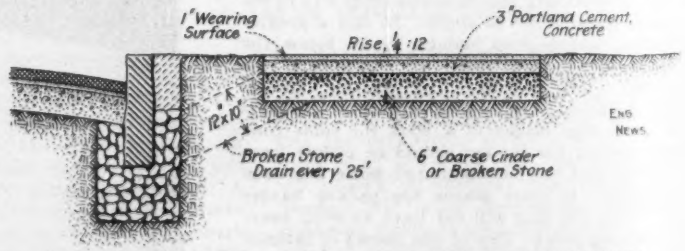


FIG. 5. SUGGESTED DESIGN FOR A CONCRETE SIDEWALK.

Curbs.

The trench shall be excavated to a depth not greater than the bottom of the curb and a width not greater than the thickness of the curb plus 6 ins.

The thickness of the curb shall not be less than 6 ins.

After the forms are set about 1 in. of wearing surface shall be placed on the inside of the curb form, then the concrete shall be deposited at one operation and firmly tamped to within 1 in. of the top of forms. The top wearing surface shall then be placed and be of the same composition as that specified for sidewalks.

Joints shall be made three-fourths the depth of the curb, continuous with joints of the sidewalk and in no case more than 6 ins. apart.

The forms shall be removed as soon as practical and the faces finished at one operation floating down 6 ins. with a one to one mixture of cement and fine aggregate of sufficient thickness to produce a smooth surface.

Where a combination curb and gutter is required they shall be cast at the same time and finished at one operation.

The Undermining of a Reinforced-Concrete Dam at Pittsfield, Mass.

An example of remarkable stability in a reinforced-concrete dam as well as of the necessity for thorough preliminary examinations of the underlying soil of dam sites, is to be noted in the recent undermining of the so-called Ashley dam at Pittsfield, Mass. After the failure, the city called to investigate the accident Mr. Desmond Fitzgerald, Past President Am. Soc. C. E., and the contractor, the Ambursen Hydraulic Construction Co., retained Mr. Wm. H. Burr, M. Am. Soc. C. E., and Mr. Robert A. Cairns, M. Am. Soc. C. E. Portions of these reports, illustrated with drawings and half-tones obtained elsewhere, are herewith given as the best available presentation of the points of engineering interest in the undermining and the possible methods of repair. As is evident from all of these reports the cause of the accident is entirely with the foundation, the responsibility for which is now a matter of controversy. We have, therefore, purposely avoided any reference to these legal details which have no connection with the technical lessons to be learned from the washout.

Mr. Fitzgerald's Report.

The dam is of reinforced concrete, of the Ambursen type (Fig. 1). It is about 400 ft. in length, 40 ft. in height at the brook, and cost the city about $70,000. It was built under contract with the Ambursen Hydraulic Construction Co. Work was started in September, 1907, and completed during the following spring. The purpose for which the dam was built was to create a distributing reservoir with a capacity of 23,000,000 gals. on Ashley brook at the point of diversion of the water to the city supply.

The reservoir was not filled until the beginning of the present year. On Jan. 7, 1909, the water, having risen to the crest of the overflow, made its way under the base of the dam at a point nearly midway between the spillway and the side hill at the southwesterly end of the dam (Figs. 2 and 3). In a short time the materials filling a space about 50 ft. in length and 20 ft. in depth were washed out from under the structure and after the reservoir was empty the dam spanned the excavation, sagging nearly a foot and was later supported on wooden cribs. Such, in brief, is the history of the structure.

The dam is triangular in form and is composed of a series of thin buttresses, united above by an inclined deck from 10 ins. to 22 ins. in thickness, resting upon a horizontal floor 18 ins. in thickness and about 50 ft. in width at the widest portion of the dam. The crest, about 2 ft. in width, is 2 ft. higher than the spillway, the latter being 48 ft. in length. The upper cut-off wall, 3 ft. in thickness, is situated at the upstream extremity of the dam, and was carried to a depth of about 8 ft. below the underside of the horizontal floor. The downstream cut-off wall was of similar construction and was carried down only about 5 ft. The top soil was stripped to a depth of about 4 ft. and the floor of the dam constructed on the stripped surface. Owing to the stiffness of the dam, through its reinforcement, it not only sustained its own weight across the washout but also held up both cut-off walls so that they hang suspended from the dam.

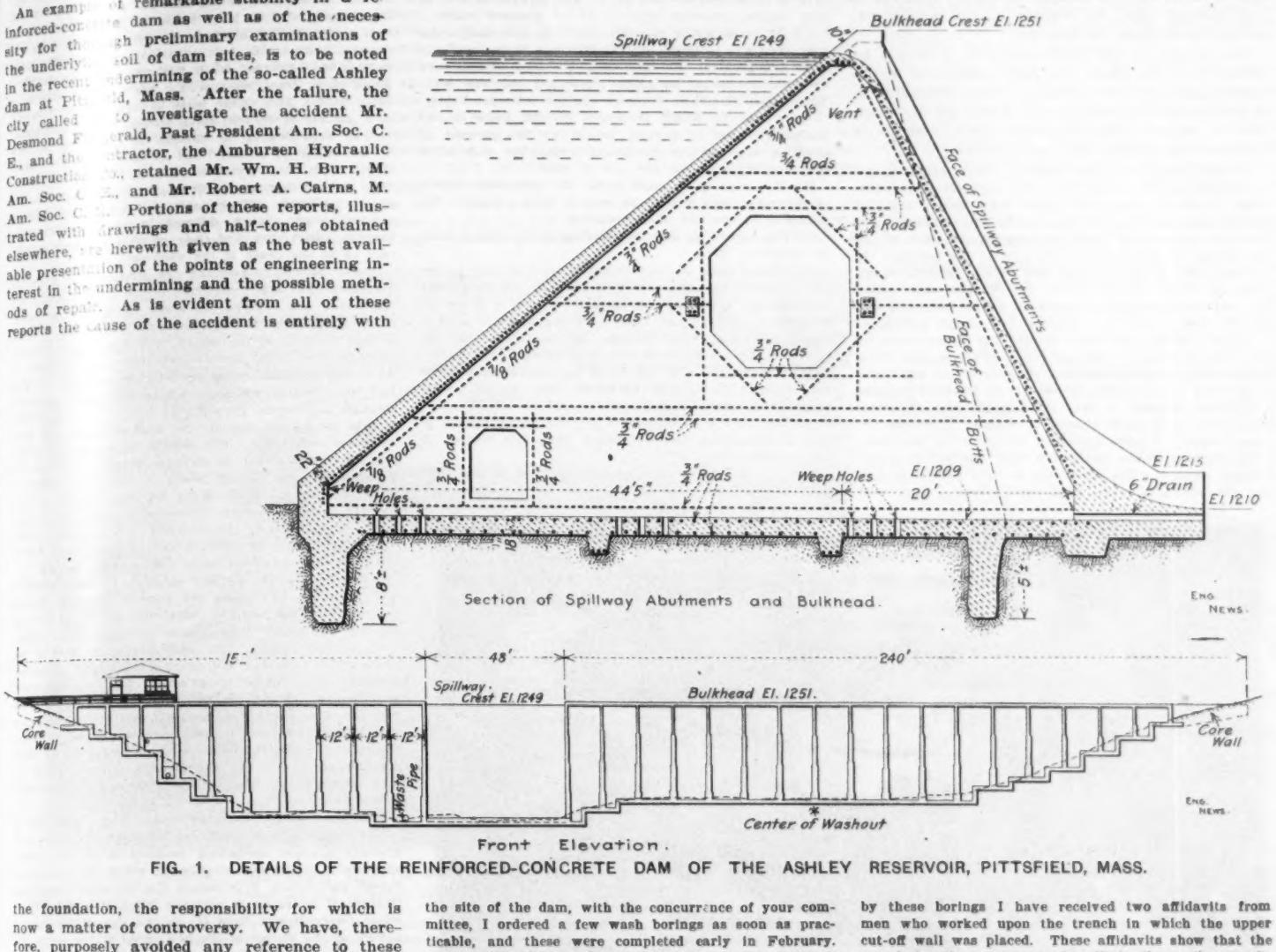


FIG. 1. DETAILS OF THE REINFORCED-CONCRETE DAM OF THE ASHLEY RESERVOIR, PITTSFIELD, MASS.

BORINGS.—Some borings across the valley 150 ft. above the dam indicate the presence of rock or other solid bottom at a depth of from 8 to 22 ft. below the surface. As no borings had been made immediately on the site of the dam, with the concurrence of your committee, I ordered a few wash borings as soon as practicable, and these were completed early in February. Charles W. Sherman has acted as my assistant in all the investigations.

Eight borings were made and in addition a number of attempts were made to sink others which materially added to the knowledge we now possess of the nature of the material underlying the dam. Two borings in the bottom of the washout indicated the possible presence of rock at a depth of 7 ft. below the excavation or about 25½ ft. below the top of the horizontal floor. Seven other efforts were made in the washout to get down to the rock, and they all were unsuccessful in reaching a lower level which points quite decidedly to the presence of rock at that elevation, although it is possible that excavations may reveal a mass of boulders instead of solid ledge. The materials through which the borings passed were a fine sand with a little clay and gravel. It is possible that the washout went down to a lower level than the bottom of the present hole and that these materials represent what was deposited at the time of the accident.

The other borings made across the valley, as close to the dam as possible on the upstream side, showed the presence of porous materials down to the level of the bottom of the upper cut-off wall (assuming that wall to have been built in a general way to about the same depth below the stripped surface). Below that level the materials were much harder and more impervious, and probably contain many boulders. The wash borings were arrested at about the same depth all the way across the valley from about 20 to 25 ft. below the surface of the ground.

AFFIDAVITS.—In addition to the evidence furnished by these borings I have received two affidavits from men who worked upon the trench in which the upper cut-off wall was placed. These affidavits show that the trench for the upper cut-off wall, in the section southerly from the brook, and embracing the wash out was sunk to a depth of 7 ft. below the underside of the horizontal floor of the dam, or about 11 ft. below the original level of the ground before stripping. In this section were found two large boulders; one of them was at the point of the washout and lay across the line of the ditch. Dynamite was used to shatter the boulder, and the cut-off wall at this point was afterwards constructed between forms which are now embedded in the concrete and are visible at the present time confirming statements in the affidavit. One of the affidavits declares that the

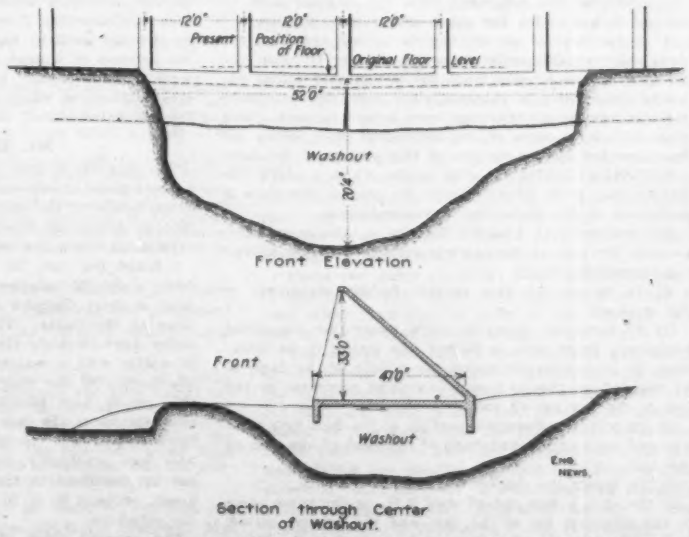


FIG. 2. FRONT ELEVATION AND SECTION THROUGH THE WASHOUT UNDER THE PITTS FIELD DAM.

trench was backfilled with whatever earth was at hand without any tamping or puddling; the workmen simply threw whatever dirt was at hand back into the trench. The bottom of the boulder was at the level of the bottom of the cut-off wall as built. It appears from one of the affidavits that the blasting of the boulder disturbed the earth in the vicinity.

[In justice to the Ambursen Co., it should be noted that it claims to have affidavits of its superintendent and assistant superintendent as well as daily records of the work, all of which are in direct rebuttal to the above charge of careless backfilling.—Ed. Eng. News.]

CONCLUSIONS.—I judge from all the evidence at my command that the cut-off wall was not carried to sufficient depth to prevent the water from finding its way under them through the dam, and that sufficient care was not exercised by those in charge of the work of the backfilling of the trench at the site of the boulder. It is clear that the water could find its way without much difficulty to the bottom of the cut-off wall, then under the wall and through the somewhat porous materials under the floor of the dam. Disaster was almost inevitable.

While I should not have favored the construction of this type of dam for this particular situation, and while doubts exist as to the ultimate stability of the structure, I consider that it is wise for the city of Pittsfield to make an earnest attempt to save the present dam, believing that there is a good chance of making it useful for many years. I have examined all parts of the dam. Over the span of the washout it held together in a surprising manner. The inside toe is very nearly in line but the lower face has gone down about a foot, and

FIG. 3. VIEW SHOWING THE HOLE IN FRONT OF PITTSFIELD DAM AFTER THE WASHOUT.

in doing so has moved a little down the stream; one of the buttresses has separated from the inclined deck by several inches and a few other cracks may be seen.

As it appeared to me at the time of my visit that the dam was not efficiently supported on the cribs in the washout I have already made the preliminary report advising the sinking of concrete piers under the buttresses for the purpose of affording more secure support; these piers will form parts of the permanent piers which are recommended for the support of this portion of the dam.

RECOMMENDATIONS.—The course which I advise the city to take in an effort to save the present structure is embraced in the following recommendations:

The course which I advise the city to take in an effort to save the present structure is embraced in the following recommendations:

(1) To secure the dam against further movement at the washout.

(2) To construct concrete piers under the suspended buttresses, these piers to be not less than 2 ft. in thickness; to be continuous across the middle of the dam; to be founded on the rock and to extend upstream to the line of the new cut-off wall.

(3) To jack the disturbed portion of the dam into position and connect the underside of the floor of the dam to the pier.

(4) To repair the cracked portions of the dam.

(5) To sink a new cut-off wall 3 ft. in thickness close to the upstream toe of the dam and the present cut-off wall. The new cut-off wall must be carried to the ledge. It should have on the upstream side half a dozen shallow buttresses. The entire upstream surface should be carefully plastered with Portland cement.

(6) The joint between the new wall and the old structure is to be covered with gravel and a layer of 2 ft. of clay puddle, protected with 18 ins. of screened gravel.

(7) All voids which may result in the materials under the upstream portions of the dam are to be carefully filled and grouted. For this purpose it may be necessary to build a number of small pipes into the new wall. These pipes should be removed and the holes filled later. It may also be found necessary to sink holes in the horizontal floor at certain points for the purpose of grouting any cavities remaining under the dam after the completion of the new cut-off wall.

(8) The piers to be built under the buttresses should be connected with the cut-off wall to form a support for this wall at the site of the washout.

(9) The backfilling and the puddling of the trench must be carefully done.

(10) The sinking of the new cut-off wall so near to the old structure may prove to be a difficult and dangerous undertaking, especially on account of the presence of boulders. I recommend that it be begun by sinking a trench covering a short section. By this means the exact condition of the work will be developed.

(11) The materials at the wash out should be cleaned out to solid filling and backfilled with strong, clean gravel, well consolidated.

(12) All of the work should be put in charge of a man of experience and he should have full control of his employees.

(13) As the repairs and reconstruction of certain portions of the lower Ashley dam are difficult of precise specification and are of such a nature that a trustworthy contractor must bid high on account of unforeseen contingencies, I recommend that the work be done by the city itself by day's labor. If the city will secure the services of a good man, accustomed to this class of work I think money will be saved, to say nothing of other difficulties which will be avoided by such a course. The estimated cost of the work above outlined is $35,000.

Mr. Burr's Report.

The dam has a total length of about 445 ft., including a short piece of low embankment on each end, the maximum height of the reinforced-concrete work being about 39½ ft. above the concrete floor resting in the shallow excavation below the original earth surface.

I found [on Jan. 20, 1900] a large hole washed out from under the southerly quarter, so to speak, of the dam, a short distance west of the foot of the easterly slope of the valley. The deepest part of this hole was under approximately three bays of the dam, each 12 ft. in width, with a maximum depth of about 18 ft. below the bottom of the floor of the dam. The opening into this pit or hole extended about 8 or 9 ft. up-stream from the toe of the dam and about 18 or 20 ft. below the down-stream toe. In fact, the down-stream end of the hole was practically continued in the channel washed out by the flood to the low ground at the bed of the brook, perhaps 60 or 70 ft. from the down-stream toe of the structure.

The exposed sides of the hole showed the gravelly stratum mixed with finer material for [illegible]pth of possibly 4 or 5 ft. below the original surface [illegible]derlaid by a much finer and apparently impervious [illegible]m of clayey material about 5 or 6 ft. in depth in [illegible]hich the up-stream cut-off wall at the base of the [illegible] was carried to a depth of 8 or 9 ft. below the or[illegible] surface at that point. Below this finer or clayey s[illegible]m there was exposed down to the bottom of the hole [illegible]ravelly mass containing, however, much fine mater[illegible]ith boulders of all sizes, from the size of a hen's e[illegible] possibly a cubic yard. This latter mass is largel[illegible]ater bearing as a number of diffused small streams [illegible] substantial volume were flowing up through the bo[illegible] of the hole at a number of points. One of these [illegible]ng streams issued from the up-stream limit of th[illegible]om of the hole and another nearly down to the [illegible]-stream toe of the structure. These substantial sub[illegible]ace flowing streams even though diffused in the [illegible]velly mass through which they find their way are p[illegible]bly signifcant as to the cause of the wash-out.

It was difficult to ascertain the precise [illegible] of events preceding the actual emptying of the res[illegible]oir through this great hole washed out under the da[illegible] As nearly as I could learn the reservoir had been [illegible]rtially filled to within 10 ft. of the top of the rollway [illegible]or a considerable period prior to the rain storm on January 7. As a result of that storm the reservoir wa[illegible]filled nearly full before water was seen issuing as slight percolation through the natural ground near to but below the down-stream toe of the dam at the location where the final wash-out took place. This issuing of water by percolation continued slowly to increase under observation for possibly one and a half hours or two hours before a clear opening was made under the dam after which that opening rapidly increased even with the blow-off gate open, so as to empty the reservoir in a very short time, producing a high flood in the valley of the brook below, but fortunately without doing any sensible damage.

There was evidence that water in small quantities had found its way under the floor of the dam and up through the weep holes in that floor especially under the easterly end where it rests upon the slope of the valley, and at other points. The conditions at the date of my examination, however, did not indicate that any sensible quantity of this water, if any at all, found its way under the floor as far as the down-stream cut-off wall. In fact the most careful examination that I could make or any information that I could ascertain regarding what occurred immediately prior to the final wash-out, does not indicate that a sensible amount of water found its way between the floor of the dam and the material immediately underneath it.

It appears rather that the origin of the wash-out is to be found in the more or less open water-bearing, gravelly stratum, containing boulders below the clayey, apparently impervious stratum in which the up-stream cut-off wall rested. It is certain that the more or less open stratum of materials is normally filled with water since water freely flowed from it, on the day of my examination, at the bottom of the hole made by the wash-out. This sub-surface flowage readily found its way down-stream not less than 6 or 8 ft. below the bottom of the cut-off wall before the wash-out. It is necessarily a part of the total flow in the valley, the visible part of which forms the stream and the latter is undoubtedly in more or less free communication with the sub-surface flow at a number of points in its course and perhaps at many points. As the volume of water in the reservoir increased during the process of filling, the pressure of this sub-surface water in the open stratum increased by the amount due to the increasing head or depth in the reservoir.

When the pressure became great enough, it would inevitably force its way to the surface either under or below the dam and would first show itself by slight percolation. As the head increased, this percolation would increase correspondingly and if no measures were taken to stop the percolation, it would enlarge its channels more or less rapidly after the flow was well established. The large increase of head therefore due to the increasing depth of water in the reservoir would naturally have the effect of forcing the water from the open sub-surface strata to the surface wherever the easiest escape could be found, and the final result would be the violent wash-out which at last took place.

After an open channel was once established the material below the dam would be violently and rapidly torn away by the out rushing water. The time required to produce the final out rush would depend upon the tenacity of the earth where the various percolations began. The material disclosed at the wash-out does not appear to be of a tenacious character except possibly the impervious stratum and I should suppose that ultimate destruction would quickly follow the formation of a freely flowing stream through the material under the dam.

RECOMMENDATIONS.—This in my judgment is the course of the various stages of the washout. It is, however, my judgment that in order to prevent the possibility of any similar failure hereafter, it will be necessary to carry a concrete cut-off wall along the up-stream

toe of the [illegible] down to the bed-rock in the valley or to the impervious stratum immediately over that bed-rock, if such a stratum exists. I have named a concrete cut-off wall because that would be more economical than any other cut-off wall of masonry. Such a wall can be built immediately adjacent to and on the up-stream side of the present cut-off wall, if the work be done in short sections not longer than 20 to 30 ft. I should recommend such a wall to be not less than 3 ft. thick and the proportions of the cement and a balanced aggregate to be such as to secure the greatest possible density. This wall can be constructed in an ordinary timber sheeted trench, as the percolation in a short trench can readily be controlled without excessive pumping.

If the material under the up-stream toe of the dam did not contain large boulders, it would be feasible to cut off percolation effectively by the use of heavy timber sheet piling or by the use of steel interlocked piling, several types of which are now available. It is my opinion, in view of the numerous large boulders disclosed in the wash-out hole, that it is impracticable to resort to such piling, either with or without steel pilot piles and that the most prudent procedure is to construct the concrete cut-off wall as outlined above.

In refilling the cut-off wall trench, the space between the wall and the earth face of the trench should first be thoroughly cleared out, including the removal of forms and any debris. The refill should then be made with selected fine material either put in place in layers not exceeding about 6 ins. thick well tamped or rammed, or similar material may be well puddled. In either case an impervious and unyielding refill should be attained so as to cut off as far as possible any passage of water along the face or faces of the cut-off wall.

The dam itself on the day of my examination appeared to be but little injured. It bridged the hole with a deflection of but a few inches without any other damage than the separation of one buttress from the reinforced-concrete inclined deck slabs at the top of the former by a crack having a maximum width of about 2 ins. and a similar separation of two or three other buttresses, showing much smaller cracks. There are also a few small cracks in the up-stream cut-off wall and in the two buttresses where the horizontal struts are joined to them. If the structure is immediately and firmly supported so that it cannot sink farther it may be jacked back into place without essential injury to it. It may be necessary to cut out a small amount of cracked concrete in a few places, and to put in new material, reinforcing if necessary with small dowels. It may be stated that the wash-out has not sensibly injured the structure.

Mr. Cairns' Report.

In most of its details the report of Mr. R. A. Cairns confirms that of Mr. Burr, so that we will only reprint here his conclusions:

I was impressed with certain evidence that exists tending to show that the cut-off wall trench was not refilled with the extreme care which the situation called for. In my own practice the highest price paid for earthwork in a dam is under this very item. The trench is thoroughly cleared out and is then filled up with selected material, the very best available. This is deposited in 4-in. layers and thoroughly compacted with rammers. Every effort is made to interpose the greatest possible resistance to the passage of water down into this trench.

That this was not done in the case of the Ashley Brook dam is evidenced by the fact that care was not exercised even to remove all the lumber used in forms or sheeting, some of which was to be seen sticking to the concrete at the time of my visit. With such facility of access to the bottom of the cut-off wall, and with the soil under the wall so susceptible to softening action it seems to me more than probable that the water from the reservoir soon began to get under the wall and rise up under the dam.

Doubtless all speculation as to how the water got under the dam is unprofitable, so far as this particular case is concerned. The fact must be admitted that it did, and that the reason lay in the failure to construct a suitable impervious diaphragm either connecting the dam with an impervious strata of clay or rock, or else extending so far below the surface that the friction encountered by the water in its long journey down to the bottom of the diaphragm and up to the surface again below the dam would have been great enough to reduce the flow to a negligible quantity.

FIG. 4. UPSTREAM SIDE OF PITTSFIELD DAM AFTER WASHOUT.
(Note the sag in upper line of dam over the washout.)

The Average Speed and Cost of Moving Freight by Rail and by Canal.

There were written to this journal not long ago two letters on the same day, asking for information regarding the relative speed and cost of freight movements by rail and by water. One correspondent wrote as follows:

Can you give the average speed per mile for carrying all kinds of freight by railroads? If the writer is not mistaken, he saw a statement from one of the railway conventions, which gave the average speed a little over six miles an hour.

We know that when the Ohio canal was in use a carload of flour could be transported from Akron to Cleveland in 24 hours, a distance of about 30 miles. This was done for years. The flour could be loaded on a canal boat in Akron one day, and be delivered in Cleveland the next day. To ship this by railroad at the present time requires all the way from two to ten days. Now why is it?

The other, referring to the discussion in Engineering News of Dec. 31, 1908, on the proposed $500,000,000 bond issue for inland waterways, wrote:

I wish to make some comparison of the cost of moving freight by canals, take for instance the Erie Canal between Buffalo and Albany, and the corresponding cost by railroad, and at the same time comparing the time in transit over each route. The fact that the bulk of the freight business is moved by the railroad rather than canal and at higher rate seems to indicate that the public are willing to pay for quicker and better service.

We have not been able to secure just the information which our correspondents desired. Mr. A. Hale, Chairman of the Committee on Car Efficiency of the American Railway Association, states:

So far as I know, there are no general statistics giving this information. The statistics compiled by this committee, which are similar to those compiled by most railroads for the information of their own officials, show an item "average miles per car per day" which runs about 25 miles. This, however, takes in all cars loaded and empty, moving or stationary.

Through the courtesy of Mr. John S. Kennedy, Secretary of the Public Service Commission for the Second District of New York State, we have received two statements bearing on our correspondents' inquiries. The first one is from Mr. W. E. Griggs, Chief of the Tariff Division of the Public Service Commission, Second District, and gives the rates on various commodities by rail between Buffalo and Albany. These are shown in the accompanying table.

RAILWAY FREIGHT RATES FOR VARIOUS COMMODITIES, BUFFALO TO ALBANY.

Commodity.	From	To	Distance, in miles.	Rate per ton.	Rate per ton per mile, mills.
Grain,	Buffalo	Albany	297	$1.60	5.4
Lumber,	"	"	"	2.20	7.4
Iron and steel articles,	"	"	"	2.20	7.4
Coal, bituminous,	"	"	"	1.25	7.4
Pig iron,	"	"	"	1.20	4
Iron bars, billets and blooms,	"	"	"	2.00	6.7
Petroleum oil,	"	"	"	2.40	8
Plaster,	"	"	"	1.60	5.4

Mr. Kennedy says:

From records on file with the Division of Traffic of this Commission, we learn that the average daily movement of carload shipments, via rail, between Buffalo and Albany is 54 miles, and that shipment is generally delivered between five and six days after its loading at Buffalo.

Another statement which Mr. Kennedy secured for us was from Mr. Winslow M. Mead, Deputy Superintendent of Public Works, New York State. It is as follows:

I beg to give you the following information relating to cost of transit between Buffalo and New York and the time of transit between Buffalo and Albany:

The rates on nearly all commodities are governed by the price fixed per bushel for carrying grain. The load dimensions are figured at from 200 to 240 tons, and the price per bushel for carrying grain of course varies with different seasons. The price asked during the navigation season of 1908 was 5 cts. per bushel at the opening of the season, later the price dropping to 4½, which was the prevailing rate for the last five months of the season. This was a higher rate than has usually prevailed. The rate has been known to be as low as 2 to 2½ cts. per bushel.

I am unable to give you the rate from New York to Albany, since very little freight which could be classed as "through freight" is left at Albany; almost none at all, in fact.

The time consumed in transit between Buffalo and Albany for horse boats is about eight days; the small number of boats equipped with steam power cover the distance in about six days.

EXCESSIVE PAVEMENT LOAD, HALSTED ST. LIFT BRIDGE.—"When the present City Bridge Engineer assumed control of the bridges belonging to the city of Chicago, the Halsted St. Lift Bridge received early attention, because the bridge had on several occasions failed in operation when the span was part way up. Examination disclosed the fact that at some earlier period 26 tons of sand had been placed beneath the pavement to crown the surface, and the counterweights had not been increased correspondingly. Therefore, at each operation, the engines had not only to overcome friction and inertia, but to lift 26 tons of unbalanced load as well. It is not surprising, consequently, that the boilers would not furnish enough steam for operating two or more times in rapid succession, and that when the steam supply was exhausted the span had to remain wherever it happened to be, all or part way up, until more steam could be generated. Before this unbalanced load of sand was removed, it required both engines operating with 100 lbs. steam pressure to lift the span, whereas, after the sand was removed but one engine with 40 lbs. steam pressure was necessary. There have been no operating troubles since the sand was removed.

"About two years since the steam plant was displaced by electric motors. Since then the cost of operation has been lower than that of most of the movable bridges and as low as that of any bridge in the city.

"The cost of maintaining the structure and machinery has been very low. The large amount of wire rope used has been thought to involve high maintenance charges, but that this idea is not well founded is conclusively shown by the facts that the bridge has been operated about 3,400 times a year for 14 years, that the original main cables are still in use, and that they are still in excellent condition."—J. L. Harrington in discussion of "Lift Bridges" before Engineers' Society of Western Pennsylvania. ("Proceedings" of the society, February, 1909.)

The Deepest Metal Mines of the World.*

As our readers are aware, the deepest gold mine is the Victoria Quarts at Bendigo, in Australia; this mine has a vertical shaft that has been sunk to 4,300 ft. and a winze that is 225 ft. deeper, making the total depth 4,525 ft. In these deepest workings, a saddle-reef has been cut, but it does not carry pay-ore; in fact, the Victoria Quartz Co. has asked the Government of Victoria for a grant of £10,000, and the Minister of Mines has replied that he would provide the money if the company would agree to sink another 1,000 ft.

In California, the main shaft of the North Star mine at Grass Valley is down 5,400 ft. on the vein, which has a dip of 28°, so that the maximum vertical depth is only 2,086 ft. At the bottom, the vein is larger and shows more gouge than on the upper levels; in consequence, more waste is mixed with the ore, reducing the average yield to $12 per ton for a width of 6 ft., as against the 18 ins. of $18 ore that was extracted from the upper workings. No defined ore-shoots exist, the mine is becoming less wet, but the prospects of profitable exploitation continue undiminished with increase of depth. The neighboring Empire mine has an incline shaft that is down 3,500 ft. on the vein but only 1,570 ft. vertically below the surface. This mine is said to be in a highly productive condition.

The Kennedy, on the Mother Lode, in Amador County, is one of the famous mines of California. The maximum depth attained is 3,254 ft., with stoping in progress from 2,000 to 3,000 ft.; and an excellent showing at the bottom. The shaft is now being sunk. Speaking in a general way, on the Mother Lode the rich ore, found at surface, reached to about 300 ft.; between that depth and 700 ft. there was, in many cases, an impoverishment, which was succeeded at 1,000 ft. with another zone of profitable ore, extending to 1,700 ft.; then the lode became poor again until about 2,500 ft., at which depth a few mines obtained another lease of life.

On the Comstock, the deepest mining now in progress is on the 2,300-ft. level of the Ophir, which is 2,552 ft. below the Gould & Curry outcrop. It will be remembered that the greatest depth attained on the Comstock was in a winze in the Mexican mine, which, before the flooding of the workings in 1884, reached down to 3,308 ft., or 3,554 ft. below the Gould & Curry outcrop.

On the Rand, the shaft of the Cinderella Deep is down to 4,200 ft. and that of the Jupiter to 4,230 ft. Johannesburg, before long, will have many deep mines. In Brazil, the Morro Velho shaft of the St. John del Rey has reached a depth of 4,264 ft.

But the deepest metal mines are still in the Lake Superior copper region. There the Red Jacket shaft of the Calumet & Hecla mine is 4,920 ft. vertical; while the Tamarack has two shafts over 5,000 ft. deep, namely, No. 5, which is 5,180 ft., and No. 3, which is 5,230 ft. vertical. These Tamarack shafts were sunk to extract ore from the copper lode first exploited in the Calumet & Hecla, and they cut a lode having a dip of 38° at a vertical depth of 4,660 ft. By attaining a depth of one mile underground and by showing with what ease operations are conducted at that great depth, these Lake Superior mines have demonstrated that man is likely to be able to penetrate at least as profoundly into the earth as the ore persists.

*Editorial, "Mining and Scientific Press," March 20, 1909.

Grade Crossing Elimination.

By A. D. CHIDSEY, JR.*

One of the most important improvements in railroad work is the elimination of grade crossings in densely populated communities and especially in the larger cities. There is hardly a municipality of any size which has not at some time agitated the question of the abolition of those crossings. This agitation is often used as a political issue, but not infrequently the desire for municipal improvement and the removal of a constant source of danger is the sole consideration.

The grade crossing danger, a result of this rapid growth and development, is a condition which could not have been foreseen in the early days of railroad construction. Every superintendent, manager or president would be only too thankful to have every grade c[r]ossing on his road eliminated, and would wel[come] some just and practical scheme for their re[mo]val. The clash that not infrequently occurs b[e]tween the municipality and railroad over grad[e] crossing abolition is due not to the difference [of] opinion as to its desirability, but to questions [of] finance, methods, and (in some cases where [more] than one road is affected) questions of poli[cy]. Similarly union passenger and freight [fa]cilities sometimes cause disagreements, not [only] between the railroads and the municipa[l] authorities, but quite often the various railro[ads] themselves.

Financial disagreements are more [often] the cause of a railroad refusing to abolish [its] crossings than all the other causes combin[ed]. The manager of a road, operating thousands [of] miles of tracks and running through hun[dreds] of towns, must consider the demands of [a] municipality, not as an isolated case but [as] one of many such cases along the line of his road. The municipal authorities, however, very rarely look beyond their corporate limits, and fail to appreciate that other places are making similar demands, and that to grant them all would mean ruin. In recent years, state laws and special acts of legislation, and agreements between railroads and municipal authorities have done much to solve the difficulties, and as a result considerable work has been done and much more is in prospect.

A condensed summary of the status of grade crossing abolition was prepared last year by the Interstate Commerce Commission, from data secured early in the year, at the request of the Committee in charge of grade crossing abolition in Wilkes-Barre, Pa. This is reproduced in the tables below. It covers legislation, statements of the amount of work done, the apportionment of its cost, etc.

*Recently Resident Engineer, Board of Engineers on Elimination of Railroad Grade Crossings in the City of Wilkes-Barre, Pa.

CITIES.

Cities.	Statistics of elimination.	Distribution of expense.	Railway.	City.
BIRMINGHAM, ALA.	No eliminations. Proposition pending under act of last legislature.			
BUFFALO, N. Y.	1888 to 1905: 65. To be eliminated under present contract 5. The 70 eliminations involve construction of 42 bridges, viaducts, etc., and closing 25 streets.	Completed structures: Right-of-way work	100%	....
		Construction	78½%	28½%
		Lands purchased	66⅔%	33⅓%
		Average	78½%	21½%
		Consequential damages	70%	30%
		Estimated future cost of structures—construction	74%	26%
		Contract with New York Central R. R., 1907: Work within streets	65%	35%
		Work outside street lines	100%	....
		Consequential Damages	55%	45%
		General policy of expense distribution laid down by commissioners: Cost of right-of-way	100%	....
		Cost of approaches	66⅔%	33⅓%
		Lands purchased	66⅔%	33⅓%
		Consequential damages	50%	50%
		City maintains viaduct bridges and approaches and subways.		
	Ten Grade Crossing Commissioners appointed by Act of 1888, are empowered to contract with railways for elimination of crossings.			
CHICAGO, ILL.	Eliminations 553; Future eliminations 678; Miles elevated 681.29; Miles to be Elevated 872.91	Railway, 100%, save that city pays damages to property and business. Past cost to railways	$46,520,250	— 99⅞%
		Damages and claims paid by city	279,945	— ⅛%
		Future cost to railways	60,190,423	
		Damage suits pending against city	503,400	
	City has a Department of Track Elevation.			
CLEVELAND, OHIO.	1905-1907: 13.	Under State Law, Railway, 50%; City, 50%. Under agreement with railway, average of apportionment for 13 eliminations was: Railway, 65%; City, 35%. Total expended by City, $1,000,000.		
DETROIT, MICH.	Eliminations on 11 streets throughout and at two special points. By agreement with railways, all grade crossings in northwestern part of city, and 15 crossings of the Michigan Central Railroad are to be eliminated.	Railways, 100%, minus damages approximating 25 or 35%. Union Depot Co., 100% construction cost of Union Depot.		
	By law, city may contract with railways. If no special agreement is reached appl ication may be made to Railroad Crossing Board, which shall find the necessity and apportion the cost.			
FT. WAYNE, IND.	No eliminations, but several under consideration.	Under special act of 1907: Railway, 75%; City, 25%; or where railway (street) occupies street—Railway, 75%; Street Ry., 10%; City, 15%.		
	Under special act of 1907, city may on petition or at its own initiative, provide for separation of grades, after due notice, hearings and preparation of specifications.			
INDIANAPOLIS, IND.	Elimination on 5 streets crossed by one or more of four railways. Grade crossings on several other streets are to be eliminated.	Cost to date: Railway, 75%; Street Railway, 10%; City, 15%. Under special act of 1905: Railway, 75%; City, 17%; County, 8%. Where Street Railway occupies street: Railway, 75%; Street Railway, 5%; City, 14%; County, 6%.		
	Under special act of 1905, Board of Public Works may, on petition or at its own initiative, provide for separation of grades.			
KANSAS CITY, MO.	No eliminations. Five viaducts recently contracted for and proposed agreement (Dec. 10, '07) with Kansas City Terminal Ry. Co. provides that company shall build all viaducts and bridges needed within city limits.	The five viaducts will be built by the railways, damages in at least one case being assessed against property benefited. Railways will equip and maintain viaducts, but city agrees to maintain viaduct pavements. Under proposed agreement with Terminal Ry. Co., company will pay total cost, including damages and maintenance.		
MILWAUKEE, WIS.	Elimination of grade crossings under way since 1903, through agreements with C. & N. W. Ry. and C., M. & St. P. Ry.	Railway all work within right-of-way and not over 50 ft. from center tracks in either direction: City damages and such costs as may legally be assessed against street railways and property holders, maint nance of structures and improvements. City built the superstructure of Bartlett Street Bridge and railway the abutments; distribution of cost of other bridges has varied with respective agreements.		
PHILADELPHIA, PA.	1888-1908: all grade crossings, Pa. R. R.	Railway: construction cost. City: damages.		
	1898-1908: all grade crossings, Phila. & Trenton R. R.	City: damages and construction up to $900,000. Railway: balance.		
	1894-1908: over 17 grade crossings, P. & R. Ry.	Railway and City jointly.		
	1904: three at No. Penn. Sct. R. R. R.	Railway, 33⅓%; City 66⅔%.		
	1901: four in Germantown, P. & R. Ry.	Railway, 66⅔%; City, 33⅓%.		
	Negotiations now under way will abolish all grade crossings and fix distribution of expenses for each case. For this purpose city has appropriated $1,000,000.			
ST. JOSEPH, MO.	No eliminations	By State law, Railway pays costs of viaducts and subways; City, approaches and damages. Law ineffective because of inability of property owners to pay the necessary heavy damages.		
	A law introduced into Legislature in 1907 placed all cost, including damages, on railways; it failed of enactment.			
ST. LOUIS, MO.	No eliminations. Proposed to eliminate Tower Grove Ave. crossings; railway to pay cost and city damages.			

SUMMARY OF THE STATUS OF GRADE CROSSING ELIMINATION, IN STATES AND CITIES.

(COMPILED BY INTERSTATE COMMERCE COMMISSION IN 1908.)

STATES.

State.	Laws and regulations.	Statistics of elimination.	Distribution of expense.
ALABAMA	.....	In general no elimination save in the city of Birmingham.	
ARKANSAS	No legislation.....	Railway eliminate wherever practicable.....	No data.
CALIFORNIA	.....	No further data.....	
COLORADO	.....	No data.....	
	Constitutionality of law creating State Railroad Commission still in question.		
CONNECTICUT	Acts of 1876, '77, '84, '88, '89. By law each railways company removes at its own expense one grade crossing each year for every 60 miles of road owned or operated.....	1889-1908; 232 eliminations out of a total of 1,193 grade crossings. All grade crossings eliminated on N. Y., N. H. & H. R. R. between New York State Line and New Haven, 73¼ miles; and all but seven between New Haven and New London, 51 miles.	When railway petitions railroad commissioners for abolition of grade crossing, railroad 100%. If petition is brought by town, borough or city, railway 75%; town, borough or city, 25%. If railroad commissioners order change without petition, railway 75%; State 25%. County pays nothing in any event.
FLORIDA	.....	No data available.....	
	No attention paid to question by State Railroad Commission.		
GEORGIA	.....	No data whatever.....	
ILLINOIS	.....	Elimination only in Chicago and Joliet, by ordinance....	Railway, 100%.
	State Railroad and Warehouse Commission has question of elimination throughout State under consideration.		
INDIANA	Under general law creating State Railroad Commission any railway may apply to Commission for separation of grades, and Commission shall issue orders and instruction and apportion expenses. Commission has no authority to initiate proceedings.	No carrier has yet made application under the law.....	
IOWA	No legislation.....	Overhead crossings: 275; undergrade crossings: 476....	
	No widespread demand for action.		
KANSAS	No state action or Board order.....	"A number of instances".....	"In a number of instances the county and municipal governments have borne part of the expense."
LOUISIANA	State Railroad Commission requires approved interlocking devices at crossings; in default of these trains must come to a full stop and whistle 200 yds. before reaching crossing.	"Not generally eliminated".....	
	Country is level and Commission has felt it inexpedient to require elevation of tracks on treatles at crossings.		
MAINE	.....	No definite data. Railroads have for several years, where they could do so without extraordinary expense, eliminated grade crossings.	"Neither towns or counties or the State provide any funds to assist in eliminating grade crossings."
MASSACHUSETTS	1890; general grade-crossing law.....	1890-1907; 165.....	Average, 18 years: Railway, 61%; State, 26%; City, 13%. No county has been assessed nor does law contemplate such assessment.
MICHIGAN	.....	A number of eliminations.....	No costs paid by the State but machinery is provided whereby cities may join with railways in improvements. No further data.
MINNESOTA	No legislation. Matter left to settlement by cities.....	Three largest cities: Over and under grade crossings, 162; grade crossings, 396.	Terms of settlement vary. Railway usually builds necessary bridge and sometimes the approaches; sometimes also pays damage costs.
	Case now pending before U. S. Supreme Court, in re right of a city to compel railways to build bridges and eliminate grade crossings, even though streets were opened subsequent to grant of right way. No grade crossing reports made to State Railroad and Warehouse Department.		
MISSOURI	No legislation.....		
MONTANA	.....	Butte: 2.....	Railway, 33⅓%; City, 66⅔%.
NEBRASKA	Railway may be required, under certain conditions, to build viaducts in cities of the first and metropolitan classes.	No general elimination ever attempted.....	Railway, 100%, except damages to abutting property.
NEVADA	.....	Reno: 1.....	Railway, 50%; City, 50%.
	Practically no eliminations.		
NEW HAMPSHIRE	.....	Records lost or cast aside in the merging of forty corporations into three railway systems; but for fifty years railways have eliminated crossings whenever practicable.	Railway, 100%.
NEW YORK I & II	Grade crossing law of 1897, amended to 1906	1897-1908: 220 June 30 1906. Unprotected crossings..... 6,793 Protected gates, signals, etc..... 1,940 Over and under grade crossings..... 1,644 10,377	Ordinary, railroad, 50%; City, 25%; State, 25%; where railway crosses existing street or road, railway, 100%; where new street or road crosses existing railway, railway, 50%; City, 50%. Railway maintains bridges and the city the approaches.
	Special acts have empowered Buffalo and New York to contract with railways: and have provided for definite work in Brooklyn and elsewhere, of which 50% is paid for by railway and 50% by city, except that city's total expenditure is usually limited to a specified sum.		
NORTH DAKOTA	No legislation.....	No data.....	No data.
	Question heretofore ignored by county and municipal authorities.		
NORTH CAROLINA	State Corporation Commision empowered by law to require lowering or raising of railway crossing.	Few eliminations. One case settled by agreement.....	In case mentioned, "division of cost."
	In future this matter will have more attention.		
OHIO	Acts of 1893, 1902, 1904. Act of 1902 empowers cities to require raising or lowering of tracks. Act of 1904 forbids future construction of grade crossings except by permission of a common pleas court.	No reports.....	Act 1893—Railway, 65%; City or County, 35%. Act 1902—Railway, 50%; City, 50%. City's share may be assessed up to 50%, against any street railway using street.
	Railways have not had initiative in eliminating grade crossings, and have usually borne total cost. A proposed law gives railways initiative, cost to be borne 65% by railways and 35% by city or county.		
OKLAHOMA	.....	None, in opinion of State Corporation Commission.....	No data.
OREGON	.....	No records.....	No data.
PENNSYLVANIA	No legislation.....	No data.....	
	State Railroad Commission too newly organized to furnish data.		
RHODE ISLAND	Special act eliminated several Providence grade crossings some years ago.		Providence eliminations—Railways, about 66⅔%; City, 33⅓%. Rhode Island railways pay a tax to cities and towns in which property is located, hence State and county bear no share of grade-crossing elimination cost.
	Proposed Act eliminates Pawtucket crossings at cost of,	Railway, 66⅔%; City, 33⅓%.	
SOUTH CAROLINA	.....	No data whatever.....	
SOUTH DAKOTA	.....	"Very few, if any, such improvements have been made by railways or by county, municipal or the State government in South Dakota."	
TEXAS	No legislation.....	Comparatively few—3 or 4.....	No data.
VERMONT	By law, each railway eliminates one grade crossing each year, for every 80 miles of line.	1907: 23.....	Town, 10% (two exceptions in 1902, 5% and 6%); State, 25%; Railway, the balance.
	Law has been operative but one year (1907).		
VIRGINIA	State Corporation Commission settles each complaint on its merits.....	N. & W. Ry. has eliminated practically all grade crossings on its double-track line.....	By law when undergrade or overgrade crossings are ordered, Railway, 50%; County Bd. of Supervisors, 50%.
WASHINGTON	No legislation.....	No data.....	
	State Railroad Commission is urging suitable legislation.		
WISCONSIN	.....	Milwaukee is requiring C. & N. W. Ry. to eliminate city grade crossings.	

Failure of Two Iron Water Tanks at Parkersburg, W. Va.

By WILLIAM M. HALL,* M. Am. Soc. C. E.

About 5.10 a. m. on Friday, March 19, 1909, at Parkersburg, W. Va., two iron water tanks, of about 1,000,000 gals. capacity each, burst, while filled. As the result of this accident, besides the damage to the city property, two lives were lost, and four persons quite seriously injured; three cottages were entirely destroyed, one church and one tenement house wrecked beyond repair, and about 15 or 20 cottages and dwellings quite seriously damaged. The loss on account of the property destroyed and injured, besides that of the city, has been estimated from $30,000 to more than $100,000, and is probably nearer $40,000 or $50,000. The writer believes that a brief description of the failure may be of some interest and value to the engineering profession.

Parkersburg is at the junction of the Little Kanawha River and the Ohio River, and has a population of about 25,000 people. A spur from the adjacent hills extends well out between the two rivers and ends in a bold knob which stands about 200 ft. high above the surface of the water in the two rivers. This knob is called Prospect Hill, and it is almost in the center of the thickly populated part of the city which is built on a plateau about 100 to 150 ft. in elevation below. The tanks were about one-half mile from each of the rivers. All of the ground between the hill and the rivers is almost entirely occupied with paved streets and with buildings.

Fig. 1 shows the relative location of the tanks before they collapsed, the topography of the hill adjacent to the tanks, the position of the pieces of tanks immediately after collapse, etc. Fig. 2, looking south along Quincy St., shows the bottom of both tanks, and in the foreground the upper piece of tank "A" lying across Quincy St. Fig. 3 indicates the method of joining the walls of the tanks to the bottom. To the present time the writer has not been able to obtain a copy of the contract and specifications for the manufacture and erection of these tanks. Both were erected by the Riter-Conley Mfg. Co., Pittsburg, Pa., one in 1883 or 1884, and the other in 1885 or 1886.

Both tanks were 65 ft. in diameter and 40 ft. high. The bottoms of the tanks were made of ⅜-in. plates, double-riveted, laid on a bed of mortar, supported by the natural ground, and a course of stone masonry about 2 ft. wide around the perimeter. The walls of both tanks were composed of ten courses of plates, each 4 ft. wide, and of thicknesses as follows, from the bottom up: No. 1, ¾-in.; No. 2, ⅝-in.; No. 3, ½-in.; No. 4, 7/16-in.; No. 5, ⅜-in.; No. 6, 5/16-in.; No. 7, ¼-in.; Nos. 8-10, 3/16-in.

A short time before the tanks burst there was a light shower. The lowest temperature during the night is reported by the local weather station as 50° F. At the time of the accident there was very little wind. There had not been any very cold weather or severe wind for several days previous thereto. It is improbable that there was any ice in the tanks. Reliable persons who passed along Quincy St. late on the afternoon before the tanks burst, state that there was no sound or other indication of leakage at that time. The Superintendent in charge of operating the water-works has informed the writer that he never saw any leaks in the tanks. The writer is not able to learn of any extensive repairs ever having been made on the tanks except the renewal of a part of the third or fourth course of plates from the top, some five years ago. These courses were partly renewed on both tanks.

Immediately before the tanks burst the writer was awake but in bed, about 500 or 600 ft. distant, with his window wide open in the direction of the tanks. He distinctly heard the first report of the bursting and all of the loudest noises which occurred in that vicinity immediately afterwards. Had it been in the daytime he would have had an almost unobstructed view of the tanks from his bed. From his memory and the information of others who heard the same sounds, he believes that the time from the initial rupture of the first tank which fell, until the last building went down and the noise ceased, was probably between three to five minutes. The writer at first thought the sound was thunder, and many other people had the same impression. There were two quite loud reports, similar to thunder but not having exactly the sound of thunder. Those two reports were no doubt the bursting of the wall of the two tanks. The time between the reports is estimated by various persons at from 20 seconds to one minute. The writer is of the opinion that they were nearly a minute apart. From about 5.20 until nearly 6 o'clock the writer was in the district adjoining the tanks where the most damage was done. Immediately after 6.30 he spent about an hour looking over the wreck of the tanks. Every day since the accident he has visited the site, and has spent from one-half to one hour on each visit examining the wreck.

By an examination of the wrecked sheets, and from the known former position and the present position of the ladders and ma… es, it is evident that the walls of the two tan… arted in nearly straight lines perpendicular t… eir bottoms at points indicated in Fig. 1. … lines of parting of both tank walls are … arkably straight and very little off the perp… ular to

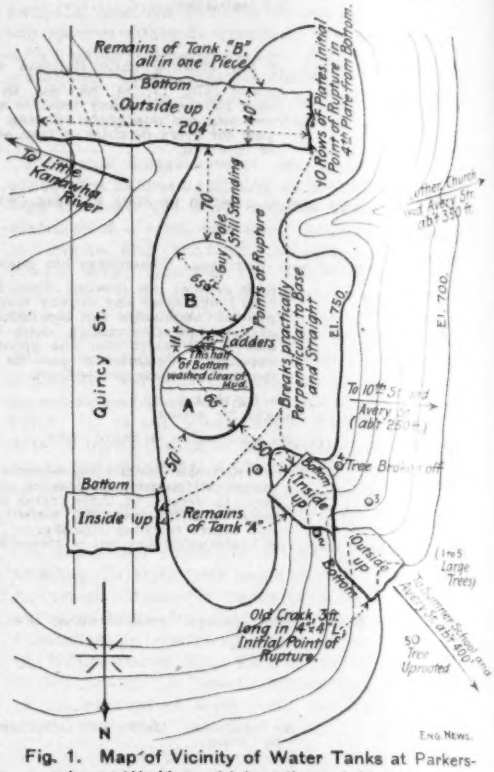


Fig. 1. Map of Vicinity of Water Tanks at Parkersburg, W. Va., which collapsed March 19.

the base. At the bottom of the break in Tank A, there is evident a crack in the 4 × 4-in. base angle which seems to be of old standing.

The tanks stood 11 ft. apart. A tape held on the circumference of tank A with the end moved from the point of rupture to tank B clearly indicates, on the ground, that the sheet of tank A in swinging around struck the wall of tank B, as indicated by the dotted lines in Fig. 1. The writer is of the opinion that tank A burst first and that the westerly side of the sheet revolved and struck tank B a terrific blow at the point indicated in Fig. 1, and tank B immediately burst from the effects of that blow. His reasons for that belief are as follows:

1. Immediately after the bursting, the entire bottom of tank B was covered with a deposit of mud from about 8 to 12 ins. in depth. The northerly half of tank A's bottom was almost entirely covered with a similar deposit, and the southerly half adjacent to tank B was washed almost clean. This indicates that tank B was partly emptied on the bottom of tank A after the contents of tank A had passed away.

2. By an examination of the line of parting of both tanks it is evident from a superficial inspection that the metal in tank A is in a much worse condition and is now of a poorer quality than that in tank B.

3. There is no indication along the parting line on tank A that it was struck or pierced. On tank B at the top of the third plate from the bottom there is a very decided indentation of the metal on both ends of the sheet, clearly indicating that it received a very heavy blow which either burst it or cracked it.

4. The present position of the tanks, and the evident movement after their walls were ruptured clearly indicates that they parted at least near the point indicated; however, this movement would have been about the same regardless of which one burst first.

The writer is also of the opinion that tank A was first ruptured at the bottom and that the sheet split straight up, and that tank B was first ruptured at the top of the third plate and that the wall split in both directions from that

FIG. 2. VIEW OF THE TANK SITE AFTER THE COLLAPSE. LOOKING SOUTH DOWN QUINCY STREET.

*U. S. Assistant Engineer, Union Trust Bldg., Parkersburg, W. Va.

rupture. His reasons for this belief are as follows:

1. The report from the rupture, as stated above, was quite loud and short, whereas if they had ruptured at the top it would not have been so loud, and would probably have been much more prolonged.

2. The tensile stresses in the metal being much greater at the bottom, the natural place of rupture is at the bottom. The condition of the metal in tank A, along the line of rupture, indicates that the rupture took place at the

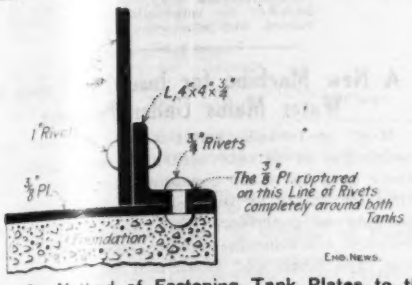


Fig. 3. Method of Fastening Tank Plates to the Foundation.

point indicated in Fig. 1. The fiber of the metal indicates that it was torn from bottom to top. On tank B along the line of parting, the fiber indicates that it was torn in each direction from the top of sheet No. 3. However, the sheets of both tank walls appear to be very hard, and the line of fracture is quite similar to that of cast iron.

From the above, and minor indications on the ground, the writer feels quite confident that both these conclusions are correct; however, it is not claimed that either one can be proven to be true beyond the possibility of a doubt.

It is also observed that the line of parting, on tank B, passed through six of the sheets and along the line of rivets on two sheets. The end of the other two top sheets, being doubled under, were not inspected. Of ten sheets of tank A seven were torn through the sheet, two along the line of rivets, and one partly through the sheet and partly along the line of rivets.

It is also observed that the walls of both tanks separated from their bottoms all the way around along the line of ¾-in. rivets connecting the 4 × 4-in. angle with the bottom, and that in the walls and in the bottoms of the tanks there are no broken rivets. The writer has not seen a single rivet that appeared to have been broken by the wreck.

No examinations of the quality of the metal have been made since the accident; however, it is understood that the city's officers propose to have examinations made.

Practically all parts of the two tanks lie as indicated in Fig. 1, except a piece of the bottom plate of tank B, which lies about 300 ft. from the tank-foundation. The three cottages which were partly destroyed were directly east of the tanks. Fig. 4 is a view of the Sumner school building some 400 ft. northwest of the tank. It will be seen that two trees pierced the foundation of the building, though fortunately they were drawn by the current of water through a window and so did not completely destroy the walls. One of these trees stood at the point marked "No. 4" in Fig. 1, and the other stood at the point marked "No. 5," so the immense force of the escaping water can be realized. It also seems quite probable that tree No. 1 (Fig. 1), about 2 ft. in diameter, separated tank A into its two pieces.

It is believed, from the appearance of the surface of the ground in the neighborhood of the tanks, and the effect of the water on the neighboring property, that 80 or 90% of the water was discharged in a westerly and northwesterly direction, between the house which lost its porch (shown in Fig. 2) and the ravine northwest of the tanks (shown in Fig. 1). From an inspection of the surface of the ground, it does not appear that more than 20% of the water could have passed east of Quincy St. This condition indicates that the westerly walls of both tanks parted from the bottom of tanks more rapidly than the easterly walls adjacent to Quincy St. It should be noted from Figs. 1 and 2 that the upper piece of wall of tank A on Quincy St. finally fell with its top course farthest away from the tank bottom, and that the wall of tank B fell with its top course towards its tank bottom.

When it is known that the two tanks held only about 2,000,000 gals. of water, the amount of street area flooded is rather surprising, not only between curbs, but on the sidewalks, which were generally 8 to 10 ins. above the paved street between curbs. It is probable that nearly half of the sidewalks were flooded over an area ½-mile wide by ¾-mile long, along streets most of which have gradients from 1 to 8%.

It appears to the writer that the most important lessons to be drawn by engineers and the city officials who are required to build or maintain such structures, are as follows:

1. A group of tanks should be located so far apart that in case one bursts, its pieces or ends cannot impinge against its neighbor with such force as to wreck it.

2. It appears that it would be wise to place each tank in a pit of such depth and diameter that the flow of water would be greatly arrested and spilled out gradually.

3. It appears that the metal should be systematically and thoroughly examined from year to year by those responsible for the maintenance; not by sounding the rivets and sheets with a hammer, but by scraping the inside walls thoroughly and thereby examine the pitting of metal all over the interior, and at points where thinnest metal is indicated opening it so as to exactly gage it, and remove samples of it for tensile test.

Of course it is preferable where possible to build with concrete or reinforced concrete and not depend upon metal exposed to rust. The above paragraph refers especially to those structures already in existence and to conditions where it is financially impracticable to build with more expensive material than metal.

SHIPWRECKS ON THE NEW ENGLAND COAST and the adjacent coast of British North America during the fall and winter season of 1908-9 involved 89 vessels and resulted in the loss of 221 lives. Of the 89 vessels affected, 6 steamers and 56 sailing craft were totally wrecked. The money loss is estimated to exceed $3,000,000.

Questions Used in Examination for Inspectors of Streets and Sewers, San Francisco Board of Public Works, Feb. 20 and 27, 1909.

Following is the scope of the examination:

Subject.	Weight.
Specifications and Materials of Construction	3½
Arithmetic and Mensuration	2
General Knowledge of Duties	2
Elements of Plane Surveying and Leveling	1
General Experience	1
Local Experience	½
Total Weight	10

"Specifications" will involve a knowledge of the requirements and inspection of materials and methods employed in constructing sewers, streets, and water-works; and "Materials of Construction" will involve a knowledge of the various materials employed in the construction of public works in this vicinity.

"Arithmetic and Mensuration" will consist of arithmetical problems and the measurement of plane and solid figures.

"General Knowledge of Duties" will embrace the general duties of an inspector and the keeping of accounts of the cost and the progress of construction.

"Elements of Plane Surveying and Leveling" will cover plane surveying and leveling, and the use of surveying and leveling instruments.

"General Experience" relates to actual experience as an inspector, civil engineers' assistant or civil engineer on construction, and will be awarded credits as follows: One year, 50; two years, 100.

A course of three years or more in a university in civil, mechanical, mining or electrical engineering, will be considered equivalent to two years of general experience.

"Local Experience" relates to experience as a surveyor, assistant engineer or inspector on construction work in the City and County of San Francisco, and will be rated as follows: One year or over, 100 credits.

"Local Experience" will count also as "General Experience."

Deductions for bad penmanship will be made throughout the examination at the discretion of the Board of Examiners.

FIG. 4. TREE THROWN 400 FT. AGAINST SCHOOL HOUSE, PARKERSBURG TANK COLLAPSE.

The examination will be held in three sessions, as follows:

First session, Feb. 20; time, 9 a. m. till 12 m.; subjects, Arithmetic and Mensuration.

Second session, Feb. 20; time, 2 p. m. till 5 p. m.; subjects, Elements of Plane Surveying and Leveling; Specifications and Materials of Construction.

Third session, Feb. 27; time, 1 p. m. till 4 p. m.; subject, General Knowledge of Duties.

Arithmetic and Mensuration.

Show all work in full.

Credit.

4. 1. Find the total cost of the following bill of lumber.
   71 pieces 10 ins. × 14 ins. × 22 ft. at $14.50 per M. (board measure).
   16 pieces 4 ins. × 10 ins. × 18 ft. at $15.30 per M. (board measure).
   127 pieces 3 ins. × 16 ins. × 14 ft. at $16.10 per M. (board measure).
   221 pieces 2 ins. × 8 ins. × 16 ft. at $21.30 per M. (board measure).

8. 2 The length of the base of a right angled triangle is 250 8/10 ft. The length of the hypotenuse is 313 5/10 ft. What is the length of the other side? What is the area of the triangle?

10. 3. A mortar box measures 5 ft. × 8 ft. inside at the bottom and 6 ft. × 9 ft. inside at the top. The inside vertical depth is 14 ins. The box is filled to a vertical depth of 7 ins. with sand. How many barrels of cement will be required to mix with this sand to form a mortar the proportions of which, measured by volume, will be 1 cu. ft. of cement to 3 cu. ft. of sand? (A barrel of cement contains 4 1/5 cu. ft.)

18. 4. The weight marked on a length of 14-in. cast-iron pipe delivered by the contractor for use in the high pressure fire system along 10th St. is 2,150 lbs., which is in accordance with the specifications. The pipe length was measured and the dimensions found to be as shown on section plan, Fig. 1 of attached blue line print.* Is the weight marked on the pipe correct? If not, what is the correct weight of the pipe delivered by the contractor? (Cast iron weighs 450 lbs. per cu. ft.)

2. 5. Add the following lengths and express the result in feet and decimals of a foot: 60 ft. 7 1/5 ins.; 13.54 ft.; 18 13/25 ins.; 10 1/6 ft.; 127 ft. 4.8 ins.

21. 6. A 3-ft. × 4½-ft. concrete sewer is to be constructed in the crossing of Mission and Eighth Sts., as shown on plan, Fig. 2, on attached blue line print. The dimensions of a cross section of the sewer are shown in Fig. 3 on the same print. How many cubic yards of concrete will be required to build the sewer from A to B on plan, Fig. 2. The concrete to be used will be composed of cement, sand and rock in the proportion of 1 cu. ft. of cement to 2 cu. ft. of sand to 5 cu. ft. of rock. Assuming no expansion in the volume of the concrete due to the mixture, how many barrels of cement will be required to build the sewer? How many cubic yards of sand? (A barrel of cement contains 4 1/5 cu. ft.)

7. 7. A brick wall resting on a steel beam is 15 ft. 10⅛ ins. long, 13½ ft. high and 15 25/100 ins. thick. In the wall there is a window 4½ ft. wide and 6 ft. 3⅛ ins. high. Assuming brick work to weigh 115 lbs. per cu. ft., how many tons of 2,000 lbs. does the beam support?

7. 8. Simplify the following:

$$\frac{4\frac{5}{8} + 5\frac{1}{8}}{9.75 - 4\frac{2}{5}} \times \frac{0.6 \times 2\ 1/6}{130} + 128.78.$$

14. 9. The measurements of the asphalt patch laid in repairing the pavement at the crossing of Grant Ave. and Bush St. are shown on plan, Fig. 4 of the attached blue line print. The contract price is 15 cts. per sq. ft. How much money should the contractor receive for the work?

9. 10. "I" St., between Tenth and Eleventh Aves. is 80 ft. in width. The length of the block is 240 ft. and the sidewalks are 15 ft. wide. A contractor is to construct a bituminous rock pavement on the above block. The specifications for the work call for a concrete foundation, 6 ins. in thickness, to be composed of cement, sand and rock in the proportion of 1 cu. ft. of cement to 3 cu. ft. of sand to 7 cu. ft. of rock. Assuming no expansion in the volume of the concrete due to the mixture, how many barrels of cement should the contractor use in the work? (A barrel of cement contains 4 1/5 cu. ft.)

Elements of Plane Surveying and Leveling.

Credit.

20. 1. Give the rod readings A. B. C. D. on the attached print.

40. 2. Give concise directions for the complete adjustment of an engineers' transit with a full vertical circle and a level under the telescope. State the order in which the adjustments should be made.

20. 3. If you were setting grade stakes for the construction of a sewer and on testing your level found it out of adjustment and you were without the means of adjusting it, what precautions would you take in using the above level to enable you to level correctly?

20. 4. Define the following terms used in leveling: Back-sight; turning point; fore-sight; height of instrument; bench mark.

Specifications and Materials of Construction.

Credit.

4. 1. (a) Describe a good quality of bricks and state how you would know a good brick from a poor one.

3. (b) Give the precautions which should be taken in laying brick where great strength is required.

6. 2. In brick work, what is meant by the following terms? (Answer by drawing a sketch in each instance.) Breaking joints; row-locking; racking back; toothing.

6. 3. What is meant by the following phrase which occurs in the city's specifications for concrete? "Concrete shall not be retempered."

8. 4. State the precautions which should be taken in reinforced-concrete construction in placing the steel.

6. 5. What is the difference between an asphalt pavement and a bituminous rock pavement?

6. 6. What defects should be looked for in inspecting cast-iron manhole frames and covers?

7. 7. What are the essential requirements for a well constructed masonry sewer?

[*None of the prints mentioned available for publication.—Ed.]

8. 8. How and when should the centers for the arch of a concrete masonry sewer be removed?

8. 9. Describe in detail how vitrified salt-glazed ironstone sewer pipe should be laid in a wet trench.

9. 10. Describe in detail the method of laying a 30-in. cast-iron water pipe in a trench 6 ft. deep.

7. 11. At what temperature should an asphaltic wearing surface for a pavement be laid? What effects are produced by its being either too hot or too cold?

7. 12. What precautions would you take to unite a new layer of concrete with old masonry?

8. 13. State briefly the important points regarding mixing (by machine) and placing heavy concrete masonry.

7. 14. Describe the proper method of keying the arch of a brick sewer.

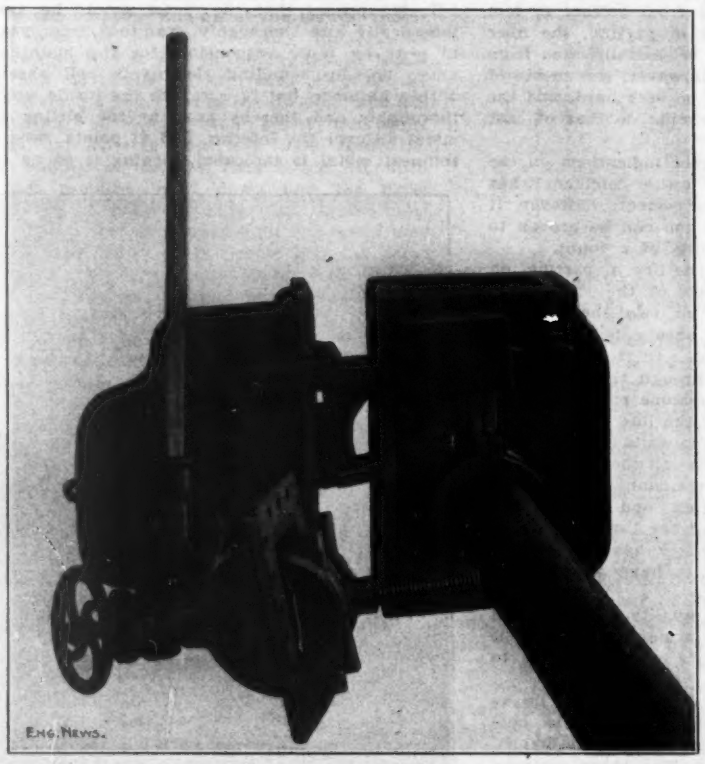
General Knowledge of Duties.

Credit.

12. 1. What are the duties of an Inspector on the construction of an important piece of public work?

5. 2. The plans show the elevation of the invert at the lowest end of a proposed sewer in Mission St., between Spear and Fremont Sts., to be 10 ft. below city base. Its grade, or rise, is 1 ft. 6 ins. in 1,000 ft. (measured horizontally). What will be the elevation of the invert (referred to city base) at points 200, 300, 550 and 700 ft. distant front the lowest end of the proposed work?

10. 3. Devise a form for daily reports for keeping a segregated account of the cost of labor on a reinforced-concrete fire cistern, or a reinforced-concrete sewer to be constructed in a street having a permanent pavement.



THE HOEFER VALVE-INSERTING MACHINE.

(Showing the valve case bolted on, the joints calked and all ready for securing the valve dome, disk and screw in place, preparatory to beginning to cut out the pipe.)

5. 4. What are the characteristics of a desirable sand for use in the concrete for an important structure, such as a fire cistern or a reinforced-concrete sewer?

5. 5. The city's specifications for sewer pipe contain the following clause: "They are to be of the best quality of vitrified, salt-glazed ironstone." What is the meaning of the word "vitrified" as therein used?

5. 6. What precautions must be taken regarding deep excavations in city streets?

5. 7. Describe the difference in the appearance of the fracture of good steel and good cast iron.

5. 8. Why should bricks be wet before laying them?

5. 9. Suppose the top of the grade stake set at one end of a 25-ft. length of sewer was 13 ft. 3 ins. above the grade of the sewer invert, and the top of the stake at the other end was 11 ft. 7 ins. above the grade of the sewer invert. How would you fix the grade line for the construction of the sewer?

13. 10. A steel I-beam delivered by the contractor for use in reinforcing the roof of the junction structure on the sewers to be constructed at 18th and Division Sts., was measured by the inspector and the dimensions of the cross-section found to be as shown on attached blue line print, Fig. 1. The specifications call for a 10-in. I-beam weighing 35 lbs. per lin. ft. Is the beam delivered by the contractor in accordance with the specifications? What is the weight per foot of length? (Steel weighs 490 lbs. per cu. ft.) Show all your work.

5. 11. State the precautions that should be taken by the inspector in inspecting the placing of concrete on an important structure.

5. 12. State the requirements of cast iron stone pipe for use in construction of a sewer, and tell how you would inspect the same.

10. 13. In driving piles what causes them to broom at the top? What is the remedy?

10. 14. Suppose a pile were being driven and when down about 50 ft. below the surface its penetration under a certain blow of the hammer ceased.

What would you conclude if under continued driving with the same blow of the hammer its penetration gradually resumed, and what would you do?

A New Machine for Inserting Valves in Water Mains Under Pressure.

Most up-to-date water-works, whether under municipal or private control, now recognize that their duty to water consumers necessitates shutting off water as infrequently and for as short periods as possible. With this in view it has become common to provide machines for making taps large and small and for cutting mains for inserting valves without shutting off the flow of water.

We describe herewith a new valve-inserting machine. This device differs from the Sherrerd & French machine (see Eng. News, Feb. 16, 1899) in that it employs two saws, one at each end of the cut, to remove the section of pipe, instead of making use of a revolving cutter. There are, of course, other differences in details.

The accompanying photograph gives a good general idea of the new machine after attachment to the pipe in which the valve is to be inserted, but before the valve dome gate and stem have been put in place.

The two parallel saws are connected by cross pieces. A reciprocating motion for the saws is secured by a rocking shaft supported in stuffing boxes. The crank arm is keyed on the shaft, and the shaft itself is moved by means of the lever shown in the illustration. After the cut has been made, the section of pipe which is to give place to the valve is withdrawn into the saw casing. The gate of the valve is then screwed down, and thus the water shut off for the brief period required to remove the saws and their accessories. The Ludlow common double-gate expansible valve is used with the machine. The machine itself was designed and is built by the Hoefer Manufacturing Co., of Freeport, Ill. The company reports that one of the machines has been tested by the local water company. The company claims as one of the particular merits of its machine that it can be operated by any intelligent pipe foreman.

STREET CAR ACCIDENTS in New York City continue with practically undiminished frequency. In our issue of Sept. 10, 1908, pp. 277, 281, we gave statistics of such accidents during the first seven months of 1908. We give below the figures for February of that year and the average of the seven months together with those for February of the present year:

	Feb., '08.	Av., Jan.-Feb., '08.	Feb., '09.
Total accidents	3,951	4,788	3,580
Total injuries	2,157	2,982	2,188
Total serious injuries (included in above.)	139	212	191

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Col. Dunn's paper in this issue on the Bureau of Explosives sets forth very briefly the facts about a unique institution, which is doing a work for safeguarding the traveling public that ought to be more widely known and appreciated. The Bureau is a remarkable example of cooperation between the railways and the Government in bringing about reforms, and represents an almost ideal kind of Government regulation. The Bureau was originally organized by the railways themselves and the Government cooperated in its development by furnishing the services of Col. Dunn of the Army as an expert on explosives. Eventually it became evident that to do the most effective and thorough work for public safety, the Bureau should be backed by the authority of law. Congress enacted the necessary legislation, and the Bureau is now an official body. Its work is carried on, however, in cooperation with the American Railway Association. Those of our readers interested in obtaining a fuller account of the Bureau and its work should obtain the full report of Col. Dunn.*

An interesting note as to one ramification of the Bureau's work appeared in the newspapers this week. It seems there is more to be done than simply reforming the shipping practice of the powder-makers. There are dangers even in the passenger or baggage car. Miners and contractors' laborers have a habit of carrying stolen dynamite in their personal baggage. A hand-bag or a trunk in which a few pounds of high-power explosive are hidden is a rather disquieting traveling companion—for the other passengers. The Bureau has directed the attention of all railways to this practice and hopes to combat it by spreading the warning of its prevalence.

Recently a case of this kind was discovered when a valise, checked as baggage, came open while in transit and disclosed a collection of dangerous explosives. Two foreigners had delivered it to the railroad. They were arrested and are now in jail awaiting trial in a federal court, for violating the act of Congress approved May 30, 1908.

The case cited is the third discovered within a few months.

There is a stringent law against the practice, of course, but like most other laws it is of little value without the policeman. In this case the railways themselves must be the policemen, with their Bureau of Explosives to keep them spurred up to their duty.

*Issued by the Bureau of Explosives, 24 Park Place, New York City; price, $1.

Old Hammurabi, who founded Babylon and ruled over its dawning glory some 4,000 years ago, was a patron of the engineer. He turned the river away from the frequent flooding of the city and diverted its waters to the use of his people and he builded structures which outlived him by the lifetime of a nation. But his fame is most securely founded on his formulated laws, the earliest codification known to man. From those laws it is evident that his patronage of the craftsman did not blind a sense of obligation to the citizen, for we read that

If a builder has built a house for a man, and his work is not strong, and if the house falls in and kills the householder, the builder shall be slain.

Here is a hint to our modern framers of building laws! We venture to guess that executions of builders in early Babylon were rare.

Newspaper Comments on Engineering Work.

It is a source of great satisfaction to the engineer that his work is so well appreciated and so accurately set forth by the newspaper press. When an engineer is responsible for the conduct of a work in which the public is interested, he is always gratified to have it correctly and intelligently explained to the public. When criticisms are made of engineering work it is at least comforting to know that the careful conductors of our daily press see to it that they are made with a clear understanding of the conditions and without misrepresentation in any way.

Of course the newspaper owners and editors deserve no particular credit for this. They fully understand that if their journals are to carry weight with intelligent readers, they must record facts and not imaginary happenings. If they attempt to criticise technical matters, they must understand what they are talking about, or they will run the danger of making themselves ridiculous and losing prestige.

We have no doubt that most of our readers will call to mind instances within their observation where newspaper reports of engineering matters and the newspaper comments upon them have been truly remarkable with respect to accuracy and to fair and intelligent treatment of engineering work and engineers.

Particularly noticeable has been the treatment by some of our public journals of the Panama Canal work. Of course a great national enterprise enlisting popular enthusiasm would be expected to receive the support and approval of such journals. If obliged in any way to criticise the conduct of the work, they would naturally make sure first that their criticism was based on facts and would be, on the whole, helpful rather than a hindrance to the work.

These random reflections are induced by perusal of the following editorial in the "New York Sun" of March 27:

Bunau-Varilla and the Gatun Dam.

Let us give the intrusive Gaul his due. On the twenty-fifth of February Mr. Philippe Bunau-Varilla, the inveterate advocate of the sea level waterway and the irrepressible prophet of disaster to dams built upon slimy and sliding blue clay, in the course of an address which he delivered at Boston before the Commercial Club denounced the instability of the dam at Gatun as fatal to the whole canal project. He derided the explanation given by the lock canal engineers of the settling which occurred on Nov. 25 last. He described that local catastrophe as the first warning given by nature. He predicted repetitions of the subsidence. He presented with particularity of detail his reasons for believing that the Gatun dam is an unstable structure and that the experts who recommended it and who defended it after the warning of Nov. 25, 1908, have made and are making a terrible mistake.

This address of ill omen, we say, was delivered on Feb. 25 at Boston.

On March 25, 1909, four months to a day after the first disaster and the first warning, and one month to a day after Mr. Bunau-Varilla's Boston address recording his convictions and his apprehensions, the following despatch comes from the Isthmus:

"COLON, March 25.—A section 300 ft. long of the embankment of the relocated Panama Railroad line at Gatun has settled about 30 ft. at the same spot where the last movement occurred, in November.

"The slide, however, was to the eastward and not to the westward this time. A trestle is now being rebuilt across the depression which will be filled with rocks until the former level is reached.

"Passenger trains have not used this line for several weeks, and little importance is attached to the occurrence."

Little importance attached to this second settlement of 30 ft. in the blue slime foundations!

We wonder if another board of engineering experts will be sent to the Isthmus. We wonder if the experts chosen for a second conference over the stability of the Gatun dam will be the same experts who went there in December with Mr. Taft.

Now there is engineering insight for you! What matter Col. Goethals' explanation that the settlement was in a *railway* embankment and not in the dam at all and that it occurred where the railway crosses the Gatuncillo swamp more than a mile away from the Gatun Dam site? "Little importance to be attached to such an occurrence," indeed! An engineer who would disregard such a solemn warning as that, would refuse to believe in the divining rod and deny that two and two make five.

It is such a pleasure to have the "Sun" ("in which if you see it, it's so"—to paraphrase its anti-Ananias motto) rush to the defense of the public interests in this Panama Canal matter. We are tempted to recall the long and heroic though losing fight which the "Sun" waged to prevent the building of the Rapid Transit Subway in New York City. How many times it laid down the proposition on the weight of its engineering authority that people would never, never desert the commodious and luxurious elevated trains to ride underground. And yet, alas, its efforts were vain. New York wantonly and recklessly squandered its money and credit on the Rapid Transit road and foolish people ride on it so profusely that additional underground roads to the amount of some $300,000,000 are now projected.

Truly, newspaper criticism of engineering work is a great thing. And we want to express entire agreement with the "Sun's" opening sentence above quoted. "Intrusive Gaul" is excellent; but some of us do not spell it that way.

Suggested Improvements for the Boston Metropolitan District.

An ideal with which to square development as the years go by is quite as essential to a city as to a man. That this fact is being recognized is shown by the many reports on municipal improvements being made by experts and commissions employed by associations or municipalities. Many of these reports deal largely with, and nearly all of them touch at least somewhat upon, municipal esthetics; but with rare exceptions utility is given more prominence than beauty. Art generally receives due consideration, but fitness for the service intended is the criterion.

An important report, which in this case deals rather more largely than usual with utilitarian questions, has just been made by the Metropolitan Improvement Commission, appointed in 1907 at the instance of the Massachusetts Legislature to consider the public needs of Boston and vicinity. Although there is still plenty of opportunity for municipal esthetics in the Boston Metropolitan District, much that usually comes under this head has already been achieved by the Metropolitan Park Commission and other agencies, as the report which we abstract elsewhere in this issue shows. The problems which the present Commission found most pressing were chiefly utilitarian. Nevertheless, consideration is given to esthetics in the matter of metropolitan highways and of a civic center for Boston.

The Commission found terminal transportation facilities the greatest problem connected with the future development of the Boston Metropolitan District. The same finding would result, we think, in almost any of the large municipalities of the country, particularly those upon navigable waters. We need not go into details here, nor the methods of solution proposed by the Boston Commission; but we do wish to point out that the Commission grasped the fundamental point when it recognized, as it has,

that terminal facilities should be planned and their provision rigidly supervised in the interests of the public as a whole, instead of being left to the haphazard development which is almost sure to be the result when these facilities are provided by independent and frequently rival private companies. The interests of the whole public, as they should be conceived in cases of this sort, take fully into account the needs of transportation companies as well as of the public which those companies serve. Rarely indeed, however, have the broad interests of either the transportation companies or their patrons been considered when terminal improvements have been planned for American cities. We earnestly hope that the valuable suggestions made by the Boston Metropolitan Improvement Commission will point the way to far better things.

Not the least of the difficulties of an adequate scheme for terminal facilities in any city are the questions of financing and of efficient public control. The proposition at Boston is for the formation of a terminal company composed of all the private parties in interest, with the bonds of the company guaranteed by the state and the execution of the improvements themselves under a large measure of public control. Into the details of this general plan the Commission has not attempted to go. Extensive additional investigations must be made before the details of any plan can be formulated.

Transportation terminal problems obviously center largely in Boston. This is but natural, since the vitality of any great metropolitan district always centers in its leading municipality. Common to the whole Metropolitan District is the question of improvement of main or connecting highways, a subject particularly commended to the consideration of the Commission. The report indicates clearly the need for joint action by or on behalf of the several municipalities to remedy the present defects in facilities for highway intercommunication. These defects would be for the most part easily remedied, since highways already provided go far towards serving the purposes of the whole district. This shortage is due to the independent development of the highways of each municipality with little or no regard to connecting links. Radial highways are fairly satisfactory, although suggestions are made for some additions and improvements to these. The great need is for more circumferential highways or for the links necessary to couple up those already in existence.

We are particularly glad to see that in its recommendations for meeting the need for intermunicipal highways the Commission proposes to diminish rather than increase the already large number of state and metropolitan commissions. It suggests, as we have pointed out elsewhere, that the metropolitan highway matters should be put in control of a commission formed by consolidating the present Metropolitan Park Commission and the Metropolitan Water and Sewerage Board. It also suggests—and in the suggestion lies a germ which may yet develop something of great proportions—the formation of a metropolitan advisory council, to be composed of the mayors and chairmen of selectmen of the 39 municipalities making up the Metropolitan District. Such a Boston Metropolitan Council would be a possible means of harmonizing the development of the several municipalities in many other particulars than those relating to main systems of highway, water-supply, sewerage and parks. On this point we need not dwell further.

But we do wish to point out that the excellent work done by the metropolitan boards already named, and that might be done by the proposed consolidated board in conjunction with the advisory council, all join together to form a remarkable instance of municipal cooperation which might well be followed in many other sections of the country. Such municipal cooperation makes quite unnecessary, or at least makes it wholly feasible to postpone, the consolidation of municipalities in metropolitan areas. The local municipal functions under this cooperative plan are left to the several municipalities.

This preservation of local functions, easy as it may seem in theory, is difficult of satisfactory achievement under the borough plan which has been tried in New York for ten years and for 20 years in the case of the Administrative County of London. Perhaps it neither ought nor need to be so; but that the difficulty exists is evident to any one who has followed Greater New York and Greater London matters in detail. This general subject was discussed at same length in our editorial columns of Feb. 16, 1899, under the title "Municipal Cooperation a Possible Substitute for Consolidation."

Finally, we wish to express a word of appreciation of the way in which the Commission has treated the question of the possible development, or perhaps we should say further development, of a civic center for Boston. Without going into much detail, the Commission has reviewed the possibilities of several sites for a new city hall. Without committing itself very definitely on the subject, it seems to prefer Copley Square as the future civic center of Boston. Here at either end, as many of our readers know, there stand those two monumental buildings that do so much credit to American ecclesiastical and municipal architecture—Trinity Church and the Boston Public Library. The moving of the Art Museum to another site seems to make available a peculiarly fitting site for a city hall located between the two buildings already mentioned. The opposite side of the square, it is logical to suppose, would eventually be used for other city buildings.

Concerning the Gatun Dam and Earth Dams in General.

From one point of view, further discussion of the Gatun Dam in these pages may seem needless. The unqualified approval of the structure by the Board of Engineers that recently visited the Isthmus, which was made up of the highest authorities on dam construction to be found anywhere, ought to settle absolutely the matter of its safety in the mind of every engineer at least.

The public, too, we believe, has accepted the Board's report as finally settling the question. One or two of the newspapers which were chiefly responsible for arousing public anxiety over the canal work emit an occasional croaking prophecy of disaster; but such publications, lacking any expert authority, carry little weight with intelligent readers.

And yet, it is unfortunately true that the results of the campaign to scare the public concerning the Gatun Dam are likely to be felt by engineers—and by the public, which will be the chief sufferer—for a long time to come. All this loose talk about the dangers to the Gatun Dam will almost certainly have the ultimate effect of leading the public to distrust earth dams in general. The tendency will be to hinder the construction of such dams, to cause waste of money in their construction by making them unnecessarily large; to excite needless public anxiety concerning them. Surely such results are unfortunate and an injury to the public which has to pay for all such works.

We are entering upon an era of dam construction. Many such structures must be built in the next few years. They are needed for public water supply, for irrigation, for river regulation, for navigation, for power development. The amount of such work that can be done is limited by the relation between its cost and the resulting benefits. Hence anything which adds needlessly to the cost of such work limits its amount and limits also the benefit which the public can obtain.

Now the fact is that the earth dam is a structure which is too little understood and too little valued by the public, anyway, and even by many engineers. Modern methods of handling earth have tended to make the earth dam more and more a structure to be preferred, wherever the local conditions are favorable. It is hardly necessary to say to our readers, who know the conservative traditions of Engineering News, that we are not advocating here any sacrifice of public safety, neither are we by any means advocating one type of dam as compared with another.

Our position is that competent engineers—and we emphasize competent—should be left free to solve their problems in the best and most economical way. To limit the engineer's work by exciting public distrust of earth dams, or of canti-

FIG. 1. GENERAL VIEW OF THE SITE FOR THE GATUN DAM. PHOTOGRAPHED FROM THE LOCK SITE, AUGUST, 1908.

A. Rock Fill on South Side of Dam Site.
B. Trestle for Rock Fill on North Side of Dam Site.
C. East Channel of Chagres River.
D. Channel of Old French Canal.
E. West Channel of Chagres River.
F. Excavation in Rock for Concrete Spillway.

lever bridges, or of reinforced-concrete buildings, or of any standard type of engineering structure is a public misfortune.

For these reasons, it does seem worth while to say something further in these columns concerning the Gatun Dam. We printed in our issue of Dec. 24 last an extended article upon the dam from the report of Mr. C. M. Saville,

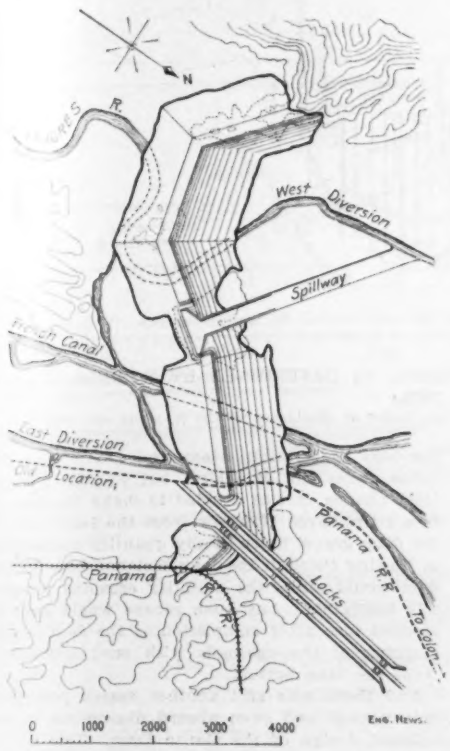


Fig. 2. General Plan of Gatun Dam.

M. Am. Soc. C. E. That article was necessarily technical and dealt with the details of experiments made to settle beyond question the safety of the structure. We shall try in what follows to consider the matter in a more general way.

In the first place, however, let us point out to the reader that such a problem as that involved in the construction of the Gatun Dam is a problem which, for complete understanding, requires study *on the site*. There are some engineering problems which can be solved better in the office or over the drawing-board, than when dealing with actual materials; but when it comes to the class of work we are here considering, one needs to actually see the local conditions and handle for himself the materials which are to be used in order to form a thoroughly clear idea of the whole problem.

Some of the criticisms which have been made of the Gatun Dam have disregarded this fundamental fact. Critics have taken some of the published reports of the engineers, have seized upon certain statements, magnified them out of relation to the other matter in the report and thereby conjured up an image of danger.

In what follows, therefore, we have to bear in mind the limitations of language. We cannot hope to express in words just the quality and texture of the material on which the Gatun Dam is built or of which it is to be made.

We would direct attention first to the accompanying view (Fig. 1) of the dam site, taken by the official photographer from a point in the lock-pit excavation last August. By studying this general view in connection with the cross-sections of the dam, Figs. 7 and 8, and the general plan, Fig. 2, the reader should be able to get some idea of what the Gatun Dam will be like.

As has been hitherto explained, the first step in constructing the dam was to dump a huge pile of rock along each side of the dam site; A and B, in Fig. 1, show these rock piles. This rock was taken chiefly from the Gatun lock-pit close by and from rock excavations at Mindi, two miles farther north on the canal line. For some time, however, two train-loads a day have been brought from Bas Obispo, at the north end of the Culebra Cut, and dumped on these piles. Between these two long piles of rock the dam itself will be built by pumping sand and clay into the area from hydraulic dredges.

A word now as to the topography of the dam site. Even to a casual observer Gatun appears to be the most desirable location at which to build a dam across the lower Chagres. The photograph, Fig. 1, shows how the hills rise on the opposite side of the valley, and nearly an equal height is reached by the hills at the back of the observer. The waters of the Chagres River flow across the dam site in three channels. The first of these, at C in the foreground, is an old channel of the Chagres and was utilized as the so-called east diversion in the French work. At D, some 800 ft. beyond, is the old French canal. Beyond this the ground rapidly rises and the rock underlies the surface at a few feet depth only. On the further side of this broad hill, at a distance of nearly a mile from the observer, flows the west channel of the Chagres, beneath the point marked E in the picture. Through the solid rock of the hill before referred to, at the point marked F, has been dug a channel for the spillway (Fig. 3).

Now let us consider what the material is on which this great dam is to rest. If one judged from the newspaper reports which have been so extensively circulated during the past few months, one might naturally suppose that the dam was to be built upon mud so soft that any material deposited upon it would be at once engulfed and disappear. Actual examination of the site gives a vastly different impression. The accompanying profile, Fig. 4, taken from the official report by Mr. Saville, shows the material on which the dam is to be built. It may be broadly characterized as good firm clay, with rock underlying it at a small depth except at two points, where deep channels have been eroded in the bed rock in some past geologic era. These deep channels, however, are filled with solid clayey material impervious to water.

The Gatun Dam, therefore, is *not* being built on a swamp or a quagmire. That the ground has good supporting power will be evident to any one by examining the photograph, Fig. 1, and noting the huge piles of rock which have been dumped from high trestles directly on the natural surface.

If it is true that as one goes to the left, away from the dam site (referring again to Fig. 1), soft material is found adjoining the river valley and material dumped upon it settles more or less. Also (as has been fully recorded in these columns) settlement occurred where this rock embankment crossed the line of the old French canal, which had been filled up in the course of 20 years with soft mud and silt. But the soft material in this channel is absolutely *not* representative of the general character of the material underlying the Gatun Dam site.

The crest of the dam was originally placed at 135 ft. above sea level. The Board of Engineers which recently visited the Isthmus in company with President Taft, recommended that this height be reduced to 115 ft., which will still make the crest 30 ft. higher than the normal level of water in Gatun Lake.

The newspaper critics seized upon this recommendation as evidence that the engineers were fearful of overloading the material underlying the dam! As a matter of fact, however, this recommendation was made simply and solely as a matter of economy. No useful purpose could be served by carrying the crest of the dam higher than 30 ft. above the water level. That portion of an earth dam above high-water level is of no use except settlement of the dam occurs, or extraordinary rise of the water level. Both these contingencies are so extravagantly provided for in the design that to take off 15 ft. from the height was certainly a very mild measure of economy.

A word may be said here regarding the provision for disposal of surplus water and regulation of the level of Gatun Lake. While the Gatun Dam is spoken of as one structure, it may almost be regarded as two separate dams, with the spillway hill rising between nearly to the height of the crest. The spillway excavation is in solid rock throughout, as may be seen in Fig. 3, and will be built up with solid concrete. It has been designed with ample width to provide for regulating the level of the lake under the greatest recorded floods. It must be remembered that the area of Gatun Lake will constitute a very large percentage of the total tributary water-shed. Therefore, notwithstanding the enormous rainfall on the Isthmus, there can be no sudden variations in the lake level, and the controlling works on the spillway crest and the sluice-gates provided through it will be ample to positively regulate the outflow and the level of the lake.

The critics of the Gatun Dam, however, have not stopped at predicting failure of the dam itself, but have declared that the water in Lake Gatun would leak out through the bottom and disappear through crevices in the rocks. One

FIG. 3. BOARD OF ENGINEERS VISITING EXCAVATION FOR SPILLWAY AT GATUN DAM, FEB. 3, 1909.

(Copyright, 1909, by Pictorial News Co.)

(The crest of the spillway will be located a short distance in front of where the party is standing. The floor of the excavation is about 10 ft. above sea level. The rock at the sides has been stepped off in terraces.)

might suppose from the criticisms which have been made that it was quite a novel and unprecedented thing in engineering to throw a dam across a river and have the basin formed above hold water.

Actually, however, this is what engineers are doing all the time. It is so rare as to be almost unknown in engineering to have any considerable leakage from a basin formed by building a dam across a river and backing up the water. These rare cases where a considerable amount of water is lost through deep underground channels occur chiefly in limestone regions where the underlying rock is honeycombed with caverns. The water must also have access to the rock crevices through porous gravel beds, and the water must not carry silt or the flow through such outlets will be soon choked.

None of these conditions which might possibly cause leakage exist in the basin of Lake Gatun. The prevalent rocks are indurated clay and trap. There is no limestone in the lower Chagres Valley. Further, the rock everywhere is covered with a thick blanket of clay. The absence of underground streams of water is indeed a notable feature of the Chagres valley. The streams are not fed by springs to any appreciable extent. They rise very rapidly when heavy rain falls and diminish their flow as quickly.

It may be recorded here that in changing the course of the Chagres River near Matachin a large quantity of clay from the Culebra Cut is being dumped into the river and carried downward in its course. Even if there were any porous gravel beds in this part of the stream, they would be effectually sealed by the puddling which the river is doing at the present time if they had not been thus sealed by the mud it has brought down in past centuries.

The Gatun Dam has been more criticized than any other feature in connection with the canal work, but the criticism has been from absolutely the wrong standpoint. It has been called an engineering monstrosity and *this* criticism is entirely valid because it is vastly bigger than there is any earthly need of or than sound engineering requires.

If a private corporation, not subject to the clamor of public criticism, were confronted with the task of throwing a dam across the Chagres Valley at Gatun, they would build a structure which would be not more than one-fifth the size of that which is now being built there. Without running any risks, without transgressing any sound principles of engineering, a competent engineer would throw a dam across the valley and create the Gatun Lake with a comparatively small percentage of the outlay in time and in money that is now being expended there.

In the report of the minority of the International Board, which originally recommended the Gatun Dam, it was pointed out that the water pressure against it would be only 1/63 of the weight of the material in the dam. This will give some indication of the enormous factor of safety in the structure as regards any possible sliding on its base; but it may be remarked as a matter of fact that even in the poorest and most cheaply built earth dams, actual failure by sliding is almost unknown. The most common mode of failure of earth dams is through being over-topped by a flood. We have already pointed out that the great area of Gatun Lake and the ample spillway, built in solid rock, eliminate possibility of failure from this cause.

Of course, a layer of gravel underneath a dam, *if it is located where the water above can find access to it*, is a thing to be avoided in dam construction. In the case of the Gatun Dam, however, the gravel stratum is overlaid at the dam site by more than 150 ft. of impervious clay. The probabilities are a thousand to one that such im-

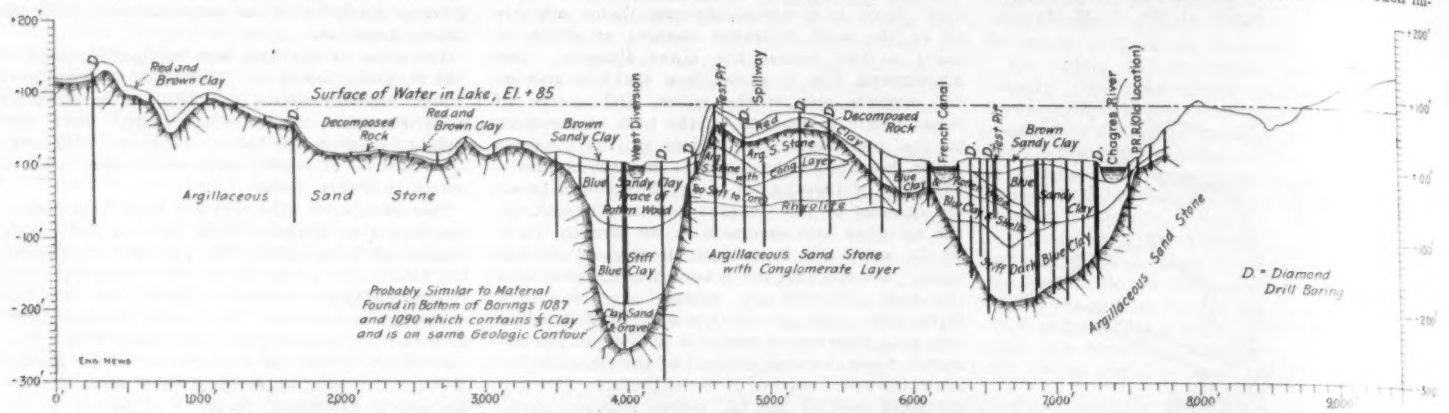


FIG. 4. PROFILE ON THE AXIS OF THE GATUN DAM SITE SHOWING UNDERLYING MATERIAL AS DETERMINED BY BORINGS.
(From Report of C. M. Saville, Assistant Engineer, Aug. 29, 1908.)
(Reprinted from Engineering News of Dec. 24, 1908. Height of dam has been reduced by recommendation of the Board of Engineers to 120 ft. above sea level.)

In the design of earth dams, also, care must be taken that the slopes are not so steep as to slide when exposed to the action of water. At Gatun, however, the materials are at hand to make such sliding impossible. The rock which is being dumped in the toes of the dam will make the slopes absolutely stable, and would detract nothing from the water-tightness of the structure if it were dumped in the dam itself. These same rock slopes would serve to protect the slopes of the dam from any possible injury through wave action.

But it may well be asked, why is the Gatun Dam given such extraordinary proportions? One might almost conclude that the engineers who designed it were fearful themselves of the dam or of its foundations since they made it of such enormous width! To understand this matter we must go back to the circumstances under which the design for the dam was originally prepared.

Public attention was turned to Gatun as a favorable site for a high dam to control the Chagres and create a navigable lake by a paper in Engineering News of July 27, 1905, by Major C. E. Gillette. At that time very little was known of conditions on the dam site. Major Gillette himself assumed the material underlying the dam site to be sand and gravel.

When the International Board of Consulting Engineers was organized, surveys and borings were made at its request on the Gatun Dam site; but there was time to make only a few borings and these were all made by the wash process and were subject to all the errors that attend this method of investigating material. When the foreman of a drill gang reported that he found gravel at such and such a depth, it went down as gravel in the records, regardless of the fact that the material accompanying the gravel might have been washed away in the issuing stream.

These borings indicated that the material underlying the dam was chiefly clay and therefore practically impervous to water except at the bottom of the deep rock gorges before referred to. Here the material was recorded as fine gravel. It was necessary, therefore, in order to be on the side of safety, to assume that such a layer of gravel existed.

FIG. 5. PIPES FOR HYDRAULIC DREDGE DISCHARGING MATERIAL IN BED OF OLD FRENCH CANAL ACROSS GATUN DAM SITE.

pervious material overlays the gravel also for miles above the dam site; but to take not the least chance, it was decided to make the dam so broad that even if water from the lake reached the deep gravel layer in any quantity the friction in flowing through the long distance beneath the dam would make the quantity escaping practically negligible. Any such escape would soon be stopped also after completion of the dam by the clogging of the channels with mud and debris from the lake bottom.

And there was still another reason justifying extravagant and even absurd dimensions in the original design of the Gatun Dam. This design was prepared, be it remembered, by some of the members of the International Board of Engineers which reported, in 1906, on the plan of the canal. It was desired, if possible, to secure the approval of the design by other members of the Board who were—to put it mildly—far from expert in dam construction. It would have been well worth while to have put some millions of dollars worth of needless material in the Gatun Dam design if thereby the objections of some members of the Board to a lock canal might have been overcome. There was serious danger that the nation might be committed to the folly of attempting the construction of a sea level canal.

Unfortunately, the majority of the members of that Commission would have none of the Gatun Dam, no matter how great a factor of safety was provided in its design. They shied at those alleged gravel layers in the deep gorges at Gatun and cited the amount of water taken from the sands of Long Island as an argument to show the "grave danger of excessive percolation!"

All this happened three years ago. Since then, as Col. Goethals stated in our issue of March 18, the site of the Gatun Dam has received a more thorough investigation than was ever given to any public or private work of any kind. The supposed gravel strata at the bottom of those deep gorges have been penetrated by drills and solid cores of the material have been brought to the surface. The gravel is found to be imbedded in clay, and the alleged porous layer is therefore just as water-tight as the rest of the dam foundation.

We have shown in the accompanying cuts, Figs. 6 to 10, several cross-sections of the Gatun Dam as planned at various dates. The first of these, Fig. 6, shows the original design accompanying the report by the Minority of the International Board in 1906, and is very general in its outlines. The following quotation from the Minority report, however, will serve to explain what was then intended:

> The cross-section of the dam has been given the unprecedentedly large dimensions shown on Plate XIV. [Reproduced in Fig. 6.] Its top is 50 ft. above the water level in the lake and 100 ft. wide; at the water level the distance through the dam is 374 ft., and at sea level the corresponding distance is 2,625 ft., or one-half mile.
>
> It is intended that the downstream toe of the dam for about 200 ft. shall be composed of rock obtained from excavation in the canal prism, so that if there should be any seepage of water through the dam there will be material at the toe which cannot be washed away. The lower part of the dam, up to elevation 50, or even to elevation 80, is to be made from material dredged from the canal between the Gatun locks and Limon Bay, pumped by a suction dredge into the dam, the process being similar to the sluicing process employed in the construction of some important dams in the western part of the United States. By this process it is feasible when using a material like the alluvial material at Gatun, which contains both coarse and fine material, to separate the two and to deposit the coarser material toward the downstream slopes, forcing the finer material to the extent desired into the upstream portion of the dam. An embankment built in this way will be water-tight.
>
> For the upstream slope, rock obtained from canal excavations will be dumped as riprap, care being taken to provide an ample thickness at and near the level where the dam will be exposed to wave action.
>
> The portion of the dam above elevation 80 will be built of impervious material to a few feet above the water level, and at higher levels may be made of either earth or rock, as most convenient. It is expected that for the upper part of the dam, spoil from the Culebra cut will be used.

Fig. 7 shows the cross-section of the Gatun Dam as published in the last annual report of the Commission and represents substantially the plan on which construction has so far been carried on. It will be seen that rock piles are made at each toe of the dam and the material between is to be pumped into place by hydraulic dredges delivering through pipe lines to the heart of the dam. Fig. 5 shows this work in progress. It has not been found feasible to adopt the recommendation above quoted from the Minority report and use in the dam the material which will have to be dredged directly from the canal prism below Gatun. The distance soon becomes excessive for economical delivery, and the material contains much vegetable matter and over-much clay. Hence instead of building the Gatun Dam of material which would have to be excavated and wasted anyway, as the Commission of 1906 expected, the bulk of the dam is to be built of material dredged from borrow pits. Explorations have developed deposits of mixed sand and clay excellently adapted for hydraulic dam composition and located within a mile of the dam.

These changes, with others, have very much increased the estimated cost of the dam. The accompanying table shows the estimate for the Gatun Dam made in the Minority Report of 1906, and in comparison therewith the estimate of its cost made by the present Isthmian Canal Commission at the end of 1908. We cannot at this time take space to discuss the wisdom of the various changes which have been made and which have caused the increase in cost.

We will only point out that subjected as the engineers in charge of the work have been to a torrent of criticism and assailed by prophecies of disaster, all of which have had undoubted effect on the public mind, it is far from strange that their efforts have been devoted rather to "making assurance doubly sure" at every point rather than to economizing in cost. It would be easy to show where millions of dollars could be saved in the construction of the Gatun Dam; but no one can blame the engineers in charge for not wishing to take the responsibility of radically revising the design. In fact, under the terms of the legislation enacted by Congress, they are actually bound to follow the general lines laid down by the Minority Report of 1906.

Similarly, the Board of Engineers which recently visited the Isthmus in company with Mr. Taft, had no authority to make radical departures from the project laid down in 1906. Their instructions were to report whether the Gatun Dam as now being built is a safe and permanent structure. Nevertheless the Commission, without departing from the general lines laid down in 1906, did recommend some changes which will effect large reductions in the cost of construction without reducing in any way the enormous factor of safety of the design. Fig. 8 shows the maximum cross-section as recommended by this Board. Besides the lowering of the height already mentioned, the Board approves the substitution for a part of the hydraulic fill of the "cheapest filling available." This will doubtless be the waste material from the Culebra cut, mixed rock and clay, which is now being wasted on the dumps at Tabernilla. The additional cost of putting it in the dam here instead of wasting it there can be little more than the additional rail haul of about 16 miles. This material should not cost more than 10 cts. per cu. yd. in place in the dam. The economy in its use compared with material pumped by hydraulic dredges is evident. It may be added that this material is rock and clay mixed and makes itself a practically impervious mass as dumped.

We have shown how the present design of the Gatun Dam has become and is kept an engineering monstrosity. We venture to submit in Fig. 9, drawn to the same scale as the preceding figures, what we have termed a "reasonable and safe design" for the Gatun Dam. The contrast between its size and that of the adopted designs is evident; and yet we believe that engineers who are thoroughly experienced in earth dam construction and who understand the local conditions at the site, will agree that this dam would be also a perfectly safe structure.

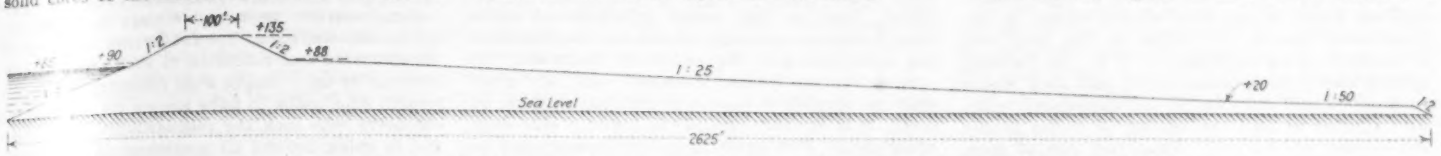


Fig. 6. Cross-Section of Gatun Dam Accompanying Report of Minority of International Board of 1905-6.

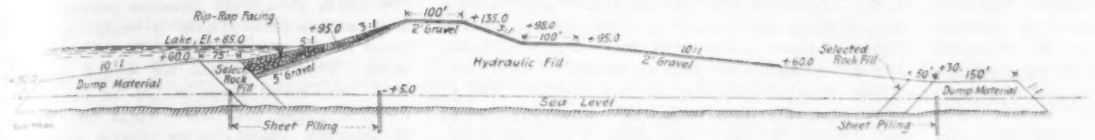


Fig. 7. Cross-Section of Gatun Dam as Shown in Report of Assistant Engineer, C. M. Saville, Aug. 29, 1908, Published in Annual Report of Isthmian Canal Commission.

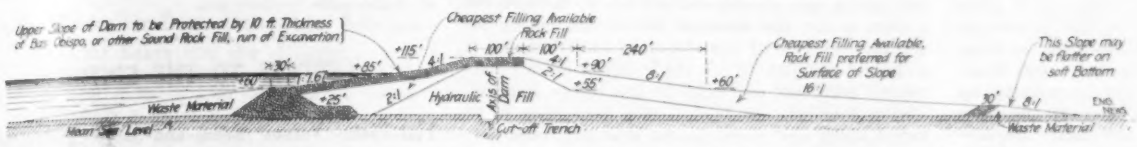


Fig. 8. Revised Cross-Section of Gatun Dam as Recommended by Board of Consulting Engineers, February, 1909.

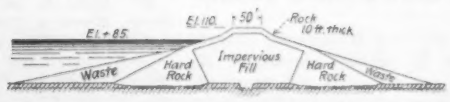


Fig. 9. A Proposition for a Reasonable and Safe Cross-Section for the Gatun Dam.

FIGS. 6 TO 9. FOUR DESIGNS FOR THE MAXIMUM CROSS-SECTION OF THE GATUN DAM.

(All the four designs are on the same scale. Fig. 6 shows the ground on which the dam rests at sea level. Fig. 7 is a cross-section through the river bed and the base is shown some 25 ft. below sea level. Fig. 8 is a section which better represents the real maximum section, as the ground level is taken about 7 ft. above sea level. In Fig. 9 the ground level is taken at the same elevation as in Fig. 8.)

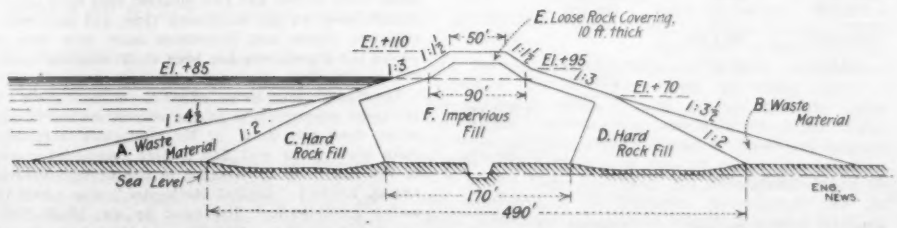


FIG. 10 PROPOSED REASONABLE AND SAFE CROSS-SECTION OF GATUN DAM ON AN ENLARGED SCALE SHOWING DETAILS.

These local conditions are a large supply of waste rock, of good quality; a still larger supply of waste material from the Culebra cut composed of mixed rock and clay, which is practically impervious as dumped from trains, and could be made almost absolutely so by sluicing down with hose streams the material as dumped.

The rock piles, C, D, are similar to those shown in Figs. 7 and 8, but have steeper slopes on the inner side toward the center of the dam and are carried to an elevation of 70 ft. In building up the rock pile C, waste earth and clay would be dumped sufficient to fill the interstices without introducing such an excess as would facilitate sliding of the pile. Thus this pile of rock on the upstream side, would itself be an effective barrier to the passage of water. Between C and D would be a fill of impervious material placed by hydraulic dredging or by dumping from trains with sluicing down of the material, as in the judgment of the engineer on the ground is most advisable. The material should have preferably sand enough in it to drain itself and be stable and yet would be practically impervious to the passage of water. The top and slopes of the dam would be covered with loose rock dumped from trains with the interstices filled with sand and gravel in the lower portion.

As an extreme safeguard against any possibility of sliding of the slopes or of bulging up of the ground outside of the base of the dam or of percolation underneath the dam, the sections A and B, of waste material from the Culebra cut might be placed. All these contingencies are so extremely remote that this additional material A, B, is only suggested because its cost is so small that it may as well be placed and because the structure is of such importance that it may be worth while to take precautions which would be absurd with any ordinary structure.

It may be added also that this design is much more massive than would be called for under any ordinary conditions. In other words, the design is not submitted as a model for earth dam construction, but as a design possessing such ample safety regardless of cost as the circumstances here undoubtedly recommended.

As we said at the outset of this article, the most important reason for the discussion of the Gatun Dam is that sound principles of earth dam design may be understood by the engineering profession and, if possible, by the public.

It is by no means necessary that an earth dam be carried to rock in order that it shall be safe. It is entirely possible to found a safe dam upon sand. Two dams have been constructed in the United States within the past two years under conditions infinitely more difficult and dangerous than exist at Gatun. At Laguna, on the Colorado River, a few miles above Yuma, Arizona, the government has just completed a dam over whose top the full flow of the Colorado has to pass, and this dam is founded upon bottomless silt. Below Yuma, at the point where the Colorado River broke through its banks and flooded the Imperial Valley, the Southern Pacific Ry., two years ago, as our readers know, constructed a dam under the greatest difficulties, which cut off the overflow of the Colorado and returned it to its old channel. Upon the integrity of this last-named dam, the existence of the whole Imperial Valley depends. In fact, if this dam were to be swept away and could not be replaced, back-cutting of the Colorado River would be carried far up beyond Yuma and cause enormous property damage.

The levees which line the Mississippi River are another example of dams hundreds of miles in extent which are not only not founded on rock, but have generally nothing but permeable silt for their support. In the alluvial plains of India the engineers in charge of the irrigation works have had to construct many dams on shifting sands and permeable silt.

Compared with any and all of these, the conditions for safe and permanent dam construction at Gatun may be considered ideal. The engineers who designed, and those who are carrying out the work of constructing the dam, have made the structure vastly beyond what reasonable provision for safety requires. We say this, however, not to criticize them. The fact is that the design of the structure was subjected to such a fire of criticism in its early stages from members of the profession who ought to have known better, that the engineers who took the responsibility were justified in going beyond all precedents in dimensioning their structure; and the engineers in charge of the work, also, were likewise justified in taking a thousand precautions to make sure at every point of the work that no chance for failure existed. The point that we would emphasize is that the Gatun Dam is not an example to be followed. The conditions which have made it a monstrosity ought to be clearly understood so that it shall not be a stumbling-block in the way of the engineer who desires to build earth dams of reasonable proportions.

TWO ESTIMATES OF THE COST OF THE GATUN DAM.

Estimate Made by the Minority of the International Board of 1906.

	Cu. yds.	Cost per unit.	Amount.	
Earth embankment:				
Below elevation + 50 dredged material pumped into dam.	12,170,000	$0.20	$2,434,000	
Between elevation + 50 and elevation + 80 dredged material pumped into dam	5,770,000	.30	1,731,000	
Above elevation + 80 material from excavation placed in dam	3,260,000	.25	815,000	
	21,200,000	23.4 cts.		$4,980,000
Excavation for diversion channel and regulating works (spillway):				
Earth	1,100,000	$0.40	$440,000	
Indurated clay (rock)	480,000	.70	336,000	
	1,580,000	49.1 cts.		776,000
Concrete in regulating works and diversion channel	189,000	$8.00	$1,512,000	
Regulating gates and machinery			320,000	
				1,832,000
Preparatory and miscellaneous				200,000
				$7,788,000

Estimate Made by the Isthmian Canal Commission. December, 1908.

	Cu. yds.	Cost per unit.	Amount.	
Earth embankment:				
Dredged material pumped into dam	7,000,000	$0.20	$1,400,000	
Dredged material pumped into dam	7,000,000	.30	2,100,000	
Dredged material pumped into dam	7,000,000	.45	3,150,000	
Rock-fill	3,400,000	.20	680,000	
	24,400,000	$0.30		$7,330,000
Excavation for spillway, etc	1,312,882	$0.70	$919,000	
Excavation for sheetpiling and stripping	360,000	1.20	432,000	
Excavation for curtain walls of regulating works	60,000	2.10	126,000	
	1,732,882	85.2 cts.		1,447,000
Concrete	200,000	$8.25	$1,650,000	
Regulating gates and machinery			320,000	
				1,970,000
Sodding				100,000
Sheet piling, lin. ft.	7,000	$60.00		420,000
Riprap	700,000	2.00		1,400,000
Miscellaneous (includes filling, trestles, pumping out old channels, etc)				875,000
				$13,572,000

Present estimate exceeds Minority estimate of 1906 by $5,784,000, as follows:

EMBANKMENT:			
Due to rock fill (new item)	3,400,000 cu. yds., at $0.20	$680,000	
Due to increase in unit prices		1,670,000	
			$2,350,000
SPILLWAY EXCAVATION:			
For curtain walls (new item)	60,000 cu. yds., at $2.10	$126,000	
For other excavation	92,882 cu. yds.	575,000	
			701,000
CONCRETE			138,000
NEW ITEMS:			
Sodding, sheet piling, riprap, etc			2,595,000
Total			$5,784,000

LETTERS TO THE EDITOR.

Flat-Plate Versus Beam-and-Slab Construction for Reinforced-Concrete Floors.

Sir: Reply to the criticism of Mr. Gottschalk (Eng. News, March 4, 1909) has been somewhat delayed.

Mr. Gottschalk makes a mistake in supposing that the writer has not used and is not thoroughly familiar with beam systems of reinforced-concrete floor construction. In fact the writer is inclined to the opinion that the Turner beam-and-slab system has demonstrated its superiority over many others whose test showing he is familiar with, and that his adoption of the mushroom system in preference to the beam system is based on the relative strengths developed by the two types under test.

Mr. Gottschalk makes a mistake in supposing the writer is making a plea for more lenient treatment from building departments than is accorded to other systems of construction. The writer's experience with building departments is that they rarely demand a test of double capacity for beams, and for this reason the inherent weakness and the defects in many types of beam design have not been brought to the attention of the profession as would have been the case had they been as severely tested as the mushroom type of construction. Full panel tests of one and two hundred tons have been commonly made on the mushroom type, and tests over two complete panels and sometimes more have been made where the department has been at all skeptical regarding the construction.

The Engineering News' editorial comment gives a very pertinent suggestion as to the correct method of computation from test data. If Mr. Gottschalk is mathematically inclined he will find a very interesting treatment of the flat plate by Grashof in the German hand-books and in Lanza's "Applied Mechanics," also a very interesting mathematical discussion by Dr. H. T. Eddy in the year book of the University of Minnesota. By taking the point of contraflexure about three-tenths of the span distant from the support it would seem that this method may be applied.

We may actually determine the stress on the steel for any load by noting the yield-point value of test load, using a uniform quality of medium open-hearth steel.

For the information of those interested the writer would say that we generally use as a working value for the steel about three-fourths that allowed by the usual building laws. Thus the steel under working loads in the mushroom system is generally strained not to exceed 12,000 to 13,000 lbs. per sq. in. against 16,000 lbs. allowed by the usual building ordinance.

Respectfully yours,
C. A. P. Turner.

Phoenix Bldg., Minneapolis, Minn., March 19, 1909.

Repairing a Break in a Mattress Bank Protection.

Sir: Near the northern city limits of Cairo, Ill., Mississippi River side, 3,500 lin. ft. of bank protection was placed during the latter part of 1907. This work consisted of ordinary brush mattress, 130 ft. wide, constructed and sunk along the shore with riprap from the inner edge to the 13-ft. stage (St. Louis gage). During the winter and spring of 1907-1908 an eddy formed at the downstream end of the work and, working upstream, flanked this part of the protection for 800 ft., leaving

the stonework 150 to 200 ft. from the bank with a deep slough between.

Repairs were begun Oct. 18, 1908, and completed Oct. 31, the stage of the river fluctuating only a few feet during this time. Two hurdles, extending from the bank to the flanked work, were built 300 and 700 ft., respectively, below the head of the caved bank—with their shore ends protected by riprap. A single row of staggered piles interspersed with a few clumps was used in the construction of each hurdle. These piles averaged 45 ft. in length and were driven 17 ft. into the bottom. Previous to driving, a brush mattress, 100 ft. wide, was made and sunk along each hurdle line. A mattress 85 ft. wide was also sunk along the entire flanked bank. Between the upstream hurdle and the head of the caving the entire space was covered, to the 15-ft. stage, with timber, cut from the bank and overlaid with a brush mattress weighted with stone.

In this work of repair 126,130 sq. ft. of brush mattress was constructed and sunk, 430 lin. ft. of hurdle was built, containing 6,118 lin. ft. of piling, and 550 cu. yds. of earth were moved.

This method was used by the writer two years ago and, proving very successful, was duplicated last year.

Very truly yours,

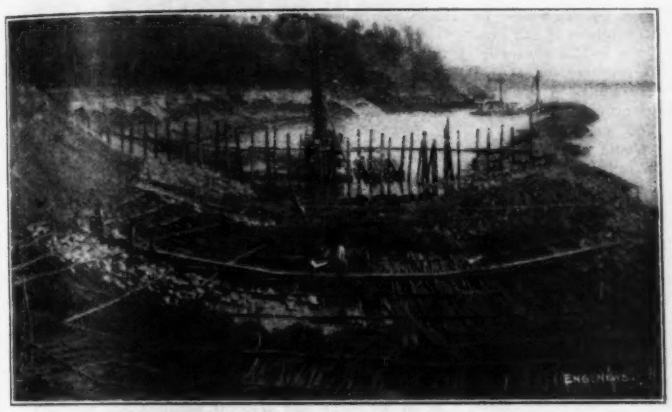
F. Y. Parker,
U. S. Assistant Engineer.

St. Louis, Mo., Feb. 22, 1909.

Canadian Routes for Deep Waterways Between the Great Lakes and the Atlantic.

Sir: Permit me to refer briefly to your editorial comment in the issue of March 4 on the Canadian Routes for Deep Waterways to the Atlantic.

The St. Lawrence and the Ottawa routes furnish the only possible economic deep waterways from the Lakes to the Atlantic, and it is a certainty that both these



REPAIR OF MATTRESS BANK PROTECTION AT CAIRO, ILL.

routes will eventually bear lake vessels to tide water. The future has room and need for both and the only problem now before the Canadian people is which should first be developed in working out the best interests of the Dominion.

To quote your article, "It can hardly be questioned by anyone that for the most economical transportation from the Lakes to the Seaboard, the lake vessel itself should be brought down to tide water to discharge its cargo." This most economical form of transportation can be realized by the construction of the Ottawa waterway at a cost of less than $100,000,000. The Government has caused this route to be very thoroughly examined and there should be no element of uncertainty in the estimates of cost. Aside from the difference of distance to Montreal, the land-locked route has some advantages in being more sheltered than the Lakes. It would be by no means a mere canal such as the Erie, but a succession of fine slack water reaches where good sailing time could be made. In the fall of the year the Ottawa route will never be closed any more than from five to eight days earlier than the St. Lawrence route. All permanent structures of any consequence will be on bed rock foundation. In the matter of construction, the Ottawa route is paralleled throughout by the Canadian Pacific Ry., besides being in touch with other Ontario and Quebec railways. Long reaches of the waterway almost 200 miles in all, are now navigated by regular steamers of large size, making the delivery of supplies and materials easy.

The deepening of the Welland Canal to 22 ft. is a project certain of accomplishment in the near future, thus adding the last of the Great Lakes to this great system of inland navigation. The course of the canal will, no doubt, be much changed in the reconstruction and the number of locks greatly reduced. The cost of such an enlargement will be in the neighborhood of $30,000,000.

You say: "With this work accomplished, lake vessels could land their cargoes at Ogdensburg, leaving only 112 miles of rail haul necessary to deliver the cargoes at tide-water in Montreal, even with the St. Lawrence in its present condition."

Then look at the new order of things and see if it be not an old order in new apparel. It is not many years ago that a 14-ft. Welland Canal permitted the large Lake freighters to bring their cargoes to Ogdensburg and the 112-mile rail haul to Montreal. For a few years a dribble of grain came by this route, thence over the Ogdensburg & Lake Champlain Ry. to the Hudson; likewise a small amount went by river-barges and by rail to Montreal. This traffic was finally cut out almost entirely by the improvement of conditions at Buffalo and increased rail facilities from that port to New York. Is it not possible that this chapter of transportation history will be repeated when, once again, a deeper Welland Canal allows the largest lake freighters to deposit their cargoes at Ogdensburg? Twenty-two feet depth in the Welland will never be an important factor in reducing cost of transportation, except to and from Lake Ontario ports, until the vastly more expensive enlargement is made from Lake Ontario to Montreal.

The improvement of the St. Lawrence from Prescott to Montreal does not present any unusual engineering difficulties aside from that of taking care of a flow of 300,000 cu. ft. per sec., where a dam is to be erected. There are nevertheless, considerations that will cause the Canadian Government to pause before undertaking it. The readjustment of levels necessary to secure a 22-ft. waterway would render entirely useless a 14-ft. canal system unequalled in the world and representing to Canada an expenditure of something like seventy millions of dollars. This fact cannot be lost sight of in any scheme of further development in the next 20 or 30 years.

Moreover, the new work must assume an international aspect not now existing. From Prescott to Cornwall (50 miles) the Canadian side of the river does not readily lend itself to further enlargement, the most feasible route lying in New York State. Necessary dams will call for international cooperation both in construction and operation. From Cornwall to Montreal the waterway will lie in Canadian territory and will be accomplished by the construction of probably three great dams, and channel deepening. When deep water extends to Montreal, it will then naturally follow that Lake St. Louis and Lake Champlain will be similarly connected, thence to the Hudson bringing Lake ships down to New York City.

In the meantime an improved Ottawa will give to Canada a 22-ft. waterway from the Great Lakes to tide-water and retain a 14-ft. channel from the Lakes via the St. Lawrence, two most valuable assets. Later on when the older system on the St. Lawrence becomes a considerable expense to keep in repair, the construction of the larger waterway can be undertaken. It is not surprising if the Canadian Government, like the Deep Waterways Commission, should be guided by "geographical and political considerations" as well as "commercial and economic" in a matter of such vital importance. It then remains for the United States to profit by the improved transportation conditions in Canada to construct the final link from the Ottawa route at Lake St. Louis to Lake Champlain and the Hudson.

Very respectfully,

E. A. Forward.

Lockport, Manitoba, March 13, 1909.

[We gather that our correspondent thinks that "geographic and political" considerations in Canada make the Ottawa route for a deep waterway preferable to the St. Lawrence route. We believe such considerations are not founded on a correct understanding of the problem. It is to the interest of Canada that the route adopted should be the one over which transportation costs will be least, including in these costs all the elements, such as the cost of making the waterway. It is not an argument against the St. Lawrence route that some of the export traffic may go to New York via Lake Champlain instead of down St. Lawrence Bay, for it will be exactly as likely to choose that route if the ships reach Montreal by the Ottawa route.

There may be difficulties, admittedly, in securing international cooperation in the creation of a deep waterway from Prescott to Cornwall; but these difficulties ought not to be insuperable.

We believe the argument of the more sheltered route through the Ottawa is fallacious. The costs of lake transport are always less than of canal or river transport, and as a matter of fact, present day lake vessels are safer in open water than in any contracted channel.

As for the present value of the 14-ft. waterway down the St. Lawrence, the small amount of traffic through it is proof that it is obsolete as a competitor of other routes to the seaboard. It is poor business policy to retain an old machine in service because so much money has been spent on it in the past if commercial conditions demand that a new machine be substituted for economic production.—Ed.]

Constitutional Prohibitions Against Tree Cutting and Land Flooding on New York Forest Lands.

Sir: That the law which prohibits absolutely the cutting of any tree, dead or alive, within the limits of the Adirondack Park and as clearly forbids the exploition of any natural resources upon State lands is not without its disadvantageous, even unfortunate aspect, is well known and readily admitted by any engineer with knowledge upon which to base an opinion. [See Eng. News, Feb. 18, 1909.—Ed.]

What this legislation *was* intended to do, at an admitted cost of the splendid advantages which are possible under development along the lines laid down in the program outlined by the Water Supply Commission of New York State, was to halt the selfish exploitation, even destruction, of the beautiful and valuable forest tract alone remaining, and which was rapidly being converted into a desolate waste of stumps, chips and "flash."

In your able editorial on the report you say: "Had a modern forestry policy * * * been formulated 20 years ago there need never have been any difficulty in adjusting forestry, water and recreation interests to each other." This is true and the law was drafted, possibly under the influence of "panic among those who wish to see the natural resources reserved for the public use and enjoyment instead of devoted to private gain;" but that this same too narrow and consequently objectionable law has prevented much irreparable damage through selfish, unscientific and "political" methods is an opinion which is, I feel, shared by many among the well informed.

Let us by all means hasten the inevitable hydro-electrical development of the water-power available, but let us place this great work and responsibility in hands so able and honest as to render unnecessary "an abject and miserable method of defense and protection of public property,' and its ultimate successful consummation a certainty within the limits of human honesty and endeavor.

E. M. Clarke.

26 Cortlandt St., New York, March 2, 1909.

[We append a condensation of an interesting address on "Forest Preservation and Conservation of Water Supply" delivered before the American Paper & Pulp Association, Feb. 4, 1909, by Hon. James W. Wadsworth, Jr., Speaker of the Assembly of the New York Legislature:

Through the courtesy of the Governor I have the honor of serving as a mmber of the State Forest Purchasing Board, which Board is charged with the duty of purchasing land for the State in the Adirondack and Catskill parks. * * *

Many years ago the State of New York started, in a small way, to acquire land in the Adirondack and Catskill Mountain regions, and by means of gradual purchasing has accumulated, on behalf of the State, what to-day is a magnificent property, totaling in round numbers a million and three-quarter acres, the great bulk of which lies in the Adirondack Park. The Forest Purchasing Board is continuing this policy of acquiring lands as fast as opportunities of so doing occur within the limit of appropriation made for that purpose by the Legislature. So great has been the inroad upon the timber supply of the United States in recent years, that we find that the price of forest land which we desire to purchase has doubled in the last five or six years, thereby making it more difficult and expensive for the State to continue this policy in years to come. However, we derive considerable consolation from the fact that timber land which we purchased several years ago has doubled, trebled and even quadrupled in value since we obtained possession of it. It constitutes to-day a great estate worth millions and millions of dollars, and held in trust for the benefit of the people of the entire State. Indeed, it has become so valuable and will continue to increase so greatly in value that, in my judgment, the time has come when we must devise more per-

fect means of protecting it and utilizing its resources—in other words, we must apply the principles of scientific forestry to its management. *To-day that vast property is lying practically idle, so far as its proper, legitimate material development is concerned, and the State finds itself hopelessly handicapped in its efforts to protect it from fire and develop it along approved scientific lines.* [Italics our.—Ed.] That provision of the State Constitution which provides that these lands shall forever be kept as wild forest lands, and the construction which has been placed upon the meaning of this language, stands squarely in the way of the best interests of the State. It is undoubtedly true that in 1894, when this constitutional provision was adopted, the State was confronted by a very serious situation. Terrific inroads had been made and more were planned upon the timber supply in the Adirondacks. In many instances the property of the State had not been free from depredations, and we were threatened with a grievous catastrophe. The people generally felt very deeply on this subject, and it was undoubtedly their idea and the idea of the framers of this clause, that a prohibition against all cutting of timber on the property of the State, whether by individuals or by agents of the State itself, should be inserted in the basic law, and stand there as a declaration on the part of the people that they wanted their forests preserved for all time. In a sense this clause was an emergency measure and, in my judgment, it was made necessary by the then existing situation. Of late years, however, the situation has changed to a great extent. The people are no less insistent for the adequate protection of their property, but, beyond that and more important, the commercial interests which before 1894 viewed with indifference and in some instances with contempt the idea of forest preservation, are to-day fully persuaded that their interests in this matter and the interests of the people of the State are identical. At the same time we have built up a great State department to-day, under the direction of the Hon. James S. Whipple, which has displayed the most faithful efficiency and a spirit of progress in the performance of its duties in protecting the property of the people. That department to-day is free from public suspicion, it has justified a hundred times over its existence, and is entitled to, and, I believe, receives the confidence of the people. Now that the State's policy in relation to its forests has become a firmly established one, now that a new and progressive spirit prevails among all classes, we find that the only obstacle standing in the way of future development and more perfect protection is that very clause in the Constitution. The Governor of the State forcibly called attention to this situation when he said in his message to the Legislature:

> Our present constitutional provision, in so far as it prevents proper care and nurture of our forest preserves, interferes with its own object. The time must shortly come when, no longer having reason to fear the grasp of the selfish hand and having settled the inviolability of the public interest in our priceless forest possessions, we shall make possible their scientific protection and their proper utilization for the public benefit.
>
> To illustrate how completely the hands of the State authorities are at present tied in this matter, it is but necessary to remind you that under the construction given to the present constitutional clause, the department cannot remove fallen timber; it cannot dispose of millions of feet of standing timber, scorched to death by the recent deplorable fires, and constituting to-day thousands and thousands of dollars worth of marketable lumber. It cannot permit the laying out of trails or roads, providing better intercommunication within the vast confines of the park; and it cannot permit the storage of water for the purpose of protecting the lower valleys of the Hudson, Black and Racquette rivers from disastrous floods, and the preservation of the great industries built up along those valleys and dependent upon an adequate flow of water the year around.
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> * * * * *
>
> I submit that it is unreasonable, short-sighted and absurd to allow 0.4% of the State's forest to stand in the way of this great increase of prosperity which lies ready at our hands. In my judgment, the State should build those storage reservoirs recommended by the Water Supply Commission, and should absolutely control them for all time; and I am of the further opinion that a plan can be devised by which the State can derive an income thereby sufficient, in a comparatively short space of time, to pay the cost of construction, the cost of maintenance, and leave a considerable surplus to go into the State treasury for the support of the general government for years to come.
>
> The government of the United States, several of the Western States, and all of the European governments which are paying any serious attention to the subject of forest preservation and conservation of water supply, are engaging in practical scientific forestry. The government of the State of New York is the only great government which cannot do so.
>
> * * * All the experts declare without reservation that judicious cutting of ripe timber is of great benefit to the forests, and this practice is indulged in and adhered to by every great government in the management of its timber lands, except the government of the State of New York. It seems to me that the time has come for this State to wake up and utilize properly the value of its great timber possessions. It seems to me that it could be done under strict State supervision; that it would yield a large annual income to the State; that it would tend to lessen the scarcity of the lumber supply; and that by doing away with much of the fallen timber it would greatly decrease the danger of forest fires and actually improve the health of the forests.
>
> In addition to this practical side of the question which I have briefly discussed, there is another equally important side, and that is the desirability of permitting the use of the Adirondack and Catskill parks by the people as great pleasure and health resorts. As I have indicated, the State is constantly increasing its holdings in these tracts, and at the same time a comparatively few individuals have purchased large tracts there for their own pleasure and enjoyment; so that to-day, between State ownership and ownership of great tracts by individuals, we find that the pleasure-seeking, health-seeking public are, in many respects, shut out from the enjoyment of those regions. As the State increases its holdings it in effect deprives the people, by just such a greater extent, of its use, paradoxical as that may seem. In fact, we have built a tight board fence around great sections of that region and we are building the fence higher and higher every year. Now, this is all wrong. My conception of the chief purpose which the State has in extending its holdings and maintaining them is to create two great public parks, one in the Adirondacks and one in the Catskills, open, under reasonable restrictions, to all the people of the State who can afford to pay the railroad fare in reaching them. They should be great pleasure-grounds, where a man of moderate means may take his wife and children and spend a month or so in the summer time in an unpretentious cottage, or camp on the shores of some one of its many beautiful lakes and ponds. A more general use of that region would be conducive to the greater health and happiness of our people. To-day, in a large measure, the public generally, with the exception of the well-to-do, are deprived of this enjoyment, are shut out by this very clause in the constitution. It seems to me that some provision should be made by the State for the use and enjoyment of its property by the people generally. Would it not be feasible for the State to permit individuals to lease for short terms, and at very low rentals, the hundreds and hundreds of available cottage and camp sites along the shores of those lakes and ponds—all under the strictest regulations and supervision? The forests themselves would not be injured, nor the waters contaminated, provided strict rules were enforced bearing upon these matters. The people would learn to love, appreciate and take a personal pride in these great, self-supporting State parks; the people generally would come to know them better, and their interest in their preservation as a great public asset would be heightened; and the mountain air and sunshine would bring a healthy tan upon many a cheek which otherwise would remain wan and pale. When we take into consideration public health, happiness and morals, we see that the greater the population of the Adirondacks and Catskills the better.

[These remarks, in view of the close touch of their author with public and political sentiment in New York State, are significant and promising. The last part of the address confirms ideas which we came near expressing in strong language in the editorial to which Mr. Clarke refers in his letter preceding our extracts from Mr. Wadsworth's address. What we had in mind was, in brief, that some of those responsible for the unfortunate Constitutional amendment at issue were prompted by the very selfish motive of wishing to keep the forest reserves as inaccessible to the general public as possible, thus restricting their use to the favored few who have the time, physical strength and money required to penetrate the wilderness, regardless of the absence, in many instances, of even poor trails.

If these vast areas of state lands cannot be made to yield a log of timber or a stick of firewood, cannot be used even in small areas to store water for state schemes, and if they are virtually inaccessible to the general public for purposes of health and recreation, with what object, then, are they being acquired by the state? We think the time has come when there should be a radical change in the policy of the State of New York towards its forest lands, and are much pleased to see the change advocated so earnestly and intelligently by a member of the State Forest Purchasing Board who is at the same time Speaker of the Assembly.—Ed.]

Experience with the California Law for Licensing Surveyors.

Sir: I note in your issue of Feb. 25 that a bill has been introduced in the Idaho House of Representatives for the purpose of grading and licensing civil engineers and surveyors in five classes. If I remember rightly you had an editorial* in your columns on a similar bill, passed (I believe) in Louisiana in 1908. California also has a license law which requires that all county surveyors, or candidates for that office, shall be licensed land surveyors; and that all work performed by a licensed surveyor shall be shown on a plat and recorded in a plat-book kept for that purpose, in the office of the recorder of the county in which the work is performed. There are three methods of licensing: by examination; by the recommendation of three licensed surveyors; or by the possession of a diploma from almost any technical school, the board of examiners being the judges as to the reputability of the school. Almost any one can find three licensed surveyors to recommend him and the result is, that by paying $10 for the license, any one who wishes it can obtain a license.

The thing is such a farce, that, of late, practically only those wishing either to run for the office of county surveyor, or desiring the effect that the words "Licensed Surveyor" after his name would have on possible clients, obtain a license. The result is that a good many people, supposing the state license to be a sort of guarantee, get bamboozled, and unless the work happens to be done by a county surveyor (who is generally competent), it has to be done all over again by a competent surveyor, if it is of sufficient importance to justify it.

This is an unbiased opinion of the workings of the license law in this state, and is not only my opinion, but is also the opinion of all the competent engineers of my acquaintance, including Mr. E. Newman, the father of the law, and at one time well known in Texas and Wisconsin as a railway locating engineer.

Although the Idaho bill differs from our law in that it requires all practicing surveyors and engineers after July 1, 1909, to obtain a license and does not have the "recommendation" proviso, still I do not believe but what a good many incompetent engineers will pass through and still be able to more easily gull people by reason of their having the license. As to the recording matter, most first-class engineers will record their surveys where it will not work harm to their clients, which should be their first consideration. Or as to that matter a law could be passed making such recording mandatory on all surveyors, without the bad features of the proposed law.

Very truly yours,
V. C. Noddin.

Hanford, Cal., March 11, 1909.

PAPER FROM SCRUB PINE has now been made commercially possible, according to an announcement of the U. S. Forest Service on the work of the Forest-Service Laboratories in Washington, D. C. When a forest of scrub pine is matured, a fully stocked stand will yield 30 to 40 cords per acre, if economically harvested according to approved methods. At the present time there is practically no general use for the timber, outside of fuel, although a coarse lumber is made of it and it is sometimes used for fencing. About 500,000 acres, or 20% of the wooded area of Maryland, and about 130,000 acres, or 10% of that of Virginia, is covered with fairly dense stands, while the broad range of the tree extends along the Atlantic seaboard from southern New York to South Carolina, and back over the Appalachians to central Indiana, where the largest specimens are found. While a number of mills have used scrub pine for the manufacture of soda pulp and ground wood, no plants have ever operated the sulphite process. The wood yields quite easily to a sulphite treatment when using an acid cooking liquor slightly stronger than the ordinary mill strength. In treatment the wood requires from eight to eleven hours, while the maximum steam pressure has not been over 60 lbs. (temperature 150° C.). The unbleached pulp in these experiments is of a light grayish or brownish color, not unlike that from spruce, of course depending upon the cooking conditions, which can be controlled to suit the manufacturer. However, a good white color is readily brought about with slightly more bleach than is ordinarily practical or economical. By cooking properly, the amount of bleach required has been brought down to 360 lbs. per ton of pulp or 35%. It is believed that still lower percentages may be employed while the color produced remains the best white. Practical paper-makers who have seen this product are almost unanimous in claiming it to be a strong, long-fibered, and hard wearing pulp, which seems desirable for bag, news, and wrapping papers. Several even went so far as to say that it would make fine bank or ledger papers when properly handled, and that this wood gave one of the best fibers which has been prepared from pine wood. One advantage for paper making which scrub pine seems to have, is a smaller loss in barking than with ordinary spruce. The logs are generally regular and not difficult to handle.

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*Eng. News, July 23, 1908.

The "Conservation" Meeting of the National Engineering Societies.

A joint meeting of the four great national engineering societies was held on the evening of March 24 to consider questions in connection with the conservation of the natural resources. The meeting was held in the large auditorium of the Engineering Societies Building in New York City, and was attended by an audience of about 700.

The presiding officer was to have been Mr. Onward Bates, President of the American Society of Engineers; but he was detained by illness in his family and the chair was taken by Dr. James Douglas, Past President of the American Institute of Mining Engineers.

The meeting opened with the reading of the following dispatch from President Taft:

John Hays Hammond:
Please say to Joint Engineering Societies that I am greatly gratified to know of their cooperation in the movement for the conservation of the natural resources of the country. The members of these societies with their technical knowledge are not only better advised as to the necessity for such conservation, but are more competent to suggest the methods by which such conservation can be carried out. I have already pledged the Administration to as full support as possible to the policy, and I am glad to renew my expression of sympathy with the movement, and to state my high estimate of the value of the aid which can be rendered by the United Engineering Societies.
(signed) Wm. H. Taft.

The White House, Washington, March 24.

Dr. Douglas in announcing the program for the evening said:

It is a pleasure to us all as engineers of different schools to meet in a common cause, for it brings home the proof of our mutual dependence. Every advance in technical science and practice is made through the cooperation of two or more of the branches of the engineering fraternities. The miner and metallurgist were always more or less helpless without the aid of the mechanical engineer, and now both must call in the electrical engineer to their assistance if engaged in work of any magnitude.

In one endeavor, however, we are all united—that is, in trying to utilize to the utmost nature's resources; for our business is to handle nature's raw material, and convert it into more or less refined and specialized compounds and forms. In so doing, we are learning more and more how to avail ourselves of nature's forces. By the very virtue of our work as we study the properties of matter, we are driven to employ as little material and as little energy—whether our own or nature's—as will serve our purpose, if for no other reason than that both material and energy cost money.

Various subjects had been assigned to the four speakers of the evening, and we condense their remarks as follows:

Conservation of Water.

By MR. JOHN R. FREEMAN.

LUMBERING AND STREAM FLOW.—It has been broadly stated that the cutting off of the forests in our eastern mountains has increased the floods, intensified the droughts and greatly injured the water power of our rivers.

The broad truth that forest cover in the mountains is beneficial for conserving and regulating stream flow and preventing soil erosion, is too firmly established to be shaken, and the work of reforesting and fire guarding should be pushed with tenfold, or a hundred fold the present vigor, but nevertheless, let us as engineers caution some of our good friends to be more careful in their application of this doctrine.

To be specific, the statements that evil effects because of deforestation have come to the water powers of the Merimack or to the navigation of the Hudson rest on fancy and not on fact.

It is my belief, based on many years' observation, that the lumbering and the clearing for agriculture that have been going on in these Eastern mountain regions for the past hundred years have not measurably affected the flow in flood or drought of any important rivers of the White Mountains or of the Adirondack region, and probably not those of the South Appalachians.

The daily flow of the Merrimack probably has been observed with precision for a longer period than any other large American river, and these precise measurements reveal no noteworthy increase in intensity of flood or drought and no decrease of average flow. Why should they? Traverse the highways and climb the hills and estimate the percentage of cleared land. You will find it surprisingly small. Note the abandoned fields and pastures that have grown up to woods. Go where the lumberman has been but five or ten years ago in these eastern mountains and see how soon his scars are healed. There are some small regions of special sterility where the fire has followed him and made a deeper scar, but the percentage of area in these is small. The sprout land is nearly as efficient as timber land for stream flow. The cutting out of scattered merchantable spruce, hemlock, balsam or pine from among the large hardwood growth, as I have observed it in the heart of the Adirondacks, can make no very material change in the melting of the snow or in the rapidity with which the rainfall reaches the river.

In these particular regions, nature frowns on agriculture and there can never be the broad denudation and change into bald prairie that we find, for example, in the Genesee Valley, and the more of thrifty hardy farmers in the mountains, the less chance that forest fires will run riot, and destroy the sponge-like humus which it may have taken hundreds of years to accumulate, and which promotes the forest growth.

I beg you not to misunderstand me. There is no more earnest lover of woods than I; no one more profoundly appreciative of our new national forest service, for I have seen its working in the Sierras and have seen the need of something like it in many places elsewhere. I would rejoice to see established a great forest reservation in the White Mountains; another in that glorious "land of the sky" extending northeast from Asheville and surrounding Mt. Mitchell, monarch of the Southern Appalachians; and I rejoice in the extension of the grand Adirondack Park so well begun by this Empire State, and in a hundred smaller forest preserves like those so wisely established by Greater Boston in the Middlesex Fells and on the Blue Hills of Milton; but let us not in our earnest advocacy make claims in their behalf which do not rest on the engineering basis, the simple truth. Therefore, I have welcomed the recent paper by Colonel Chittenden on this subject before the American Society of Civil Engineers for its timely words on the obverse of this question of forest influence upon stream flow, although I do not concur in all his views.

ACCURACY OF STREAM MEASUREMENT.—I have again and again testified to the utility of the hydrographic work of the U. S. Geological Survey, and so I will hope for pardon in pointing to places where it could be made more useful and in urging that if half the stations were abandoned and the accuracy and precision all through the year doubled at the remaining stations, under some keen traveling supervisory engineers, who could teach the inexperienced hydraulicians, whose employment is compelled by the importance of covering many stations with a scant appropriation, how to measure the flow in the ice season, how to set traps for errors of observation, and who could arouse a pride in completeness and precision of measurement, while the central office is putting emphasis on intensive work instead of nearly all its emphasis on extensive work, then, after a while, by comparing districts of similar rainfall and topography, and substrata, wooded and unwooded, or before and after close cutting, we could get some precise information on forest influences.

For this kind of work we must rely on the general government, and it is so technical and has to be so painstaking and so long continued that it is hard to make Congressmen understand its worth. I have had many opportunities, East and West, for coming in contact with the hydrographic work of the U. S. Geological Survey. From the start it has been carried on by men of high ideals, trying, under scant appropriations, to satisfy the demands of hundreds of localities and I know of no one way in which the good cause of the conservation of water can be more advanced than by helping this department to secure from Congress an appropriation commensurate with the value of its work for present and future, and then let us insist on it giving us the results of more intensive and more precise and more careful work.

WATER POWER CONSERVATION.—The hydraulic engineer bids fair to flourish for some thousands of years after the builders of steam engines and gas engines have vanished from the face of the earth. As matters stand to-day he has less urgent need of having conservation preached him than those who work with other sources of power. His turbines yield 85% of the ideal, and there is small hope of ever attaining a higher per cent. of useful effect than Uriah Boyden obtained on the Atlantic Mills turbines in Lawrence 60 years ago. The progress since that day has been chiefly in conserving the labor of the machinist who makes the turbine.

Sixty-five years ago, Storrow, in planning the power development at Lawrence, Mass., conserved the full measure of the opportunity in a way that could not be excelled to-day. But Storrow was the best educated engineer of his day, and Boyden was a physicist whose insight and skill would be honored in any of our modern research laboratories, and these works were pinnacles of achievement, not appreciated or copied broadly through the land.

Nevertheless, the chief rivers of New England, through plants that were mostly designed half a century ago, are to-day yielding nearly as much power as they could yield under ideal conditions, and they present no such margin for improvement as is presented in the manufacture of power from coal. Here and there are a few opportunities for larger storage of flood water, or for storage of water that now wastes over the dam at night, and in a few of the older plants there is some needless loss of head. The chief error of design, judged by standards of to-day, was too great a subdivision of the fall. Two or three plants under low head have been built where one plant under a high head would have been better, and too great subdivision into small scattered units has been made. The cost suffered more than the efficiency. It was conservation of capital, not that of water, which failed.

TURBINE EFFICIENCY.—In the water wheels themselves a slow process of survival of the fittest has long been going on. This was stimulated in the early days by "The Lowell Hydraulic Experiments," later by tests at Holyoke, and in recent hydro-electric times it has been further advanced by tests under working conditions in which the power has been measured by the electrical apparatus. Thus it happens that to-day the country grist mill can buy a turbine of 70 or 75% average efficiency from half load to full load, made chiefly in the foundry, at surprisingly low cost, or the great hydro-electric plant can readily procure a specially designed 5,000 or 10,000-KW. unit that will run close to the theoretic limit of efficiency.

These possibilities are not always taken advantage of. The builder of stock turbines is sometimes more sound in his machine shop practice than in his hydraulics and he not infrequently throws away 5 or 10% of useful effect by crowding twin wheels toward a common draft tube, or will crudely trim the blades of the runner in fitting a stock pattern to a special need, and in nine cases out of ten the mill owner has no means for measuring within a margin of 10% error, either the second-feet of water applied, or the horse-power derived, and therefore no means of proving the turbine efficiency within about 20%. Not long ago I made tests of representative units in a hydro-electric plant of 40,000 HP. where the turbines were wasting about 15% of the power of the water through faulty design, largely due to lack of adaptation of speed of revolution to the existing fall, and I have seen in high head plants of the Pelton type on the Pacific slope a grievous waste going on, due partly to defects in adaptation of lay-out to a variable load, to unnecessary friction of water in the conduits and approaches to the nozzle and to wasteful methods of speed regulation by deflector nozzles. Such conditions are not the rule and all these matters of water wheels and lay-out of plant are in a state of active evolution and their full measure of conservation will soon be secured.

INDUCEMENTS TO DEVELOP POWER.—Throughout the length and breadth of this land, capital has commonly been ready and sometimes too ready, to build dams and put in turbines wherever there was reasonable expectation of an ordinarily good rate of return.

Until the marvelous electrical developments of the past ten or fifteen years, great water-power developments were commonly great disappointments to those who put in the money. At Lawrence, Mass., one dividend was paid on expectations, the next twelve were passed on the facts. The original shareholders at Holyoke, Mass., Lewiston, Me., and Cohoes, N. Y., lost most of the money they put in. Our English friends and others who buried their millions at Massena, N. Y., would be pained to relate the discount at which they sold out, and there are to-day certain magnificent structures languishing half built on the Susquehanna and the Yadkin where an investor with some spare millions would be very welcome. More than one street railway or factory has found disappointment in the variable flow of a river and after liberal expenditure has come to a realizing sense of the trouble and expense of providing auxiliary power.

I mention these examples because I have noted in some of the recent conservation talk an idea that the flow of almost any river or stream of rapid descent could be easily transmuted into a never-ending flow of gold. Glowing estimates, some of them from government officials, have valued undeveloped horse-power to the extent of millions on millions of horse-power, at $20 per horse-power, which is about the current selling price for electrical power in the given locality after it has been developed and after delivery over a long transmission line, and have failed to remark that a hundred dollars per horse-power, or including transmission, perhaps a hundred and fifty dollars in hard cash had first to be added to each of these resources of nature before it was worth anything at all, and that on top of this capital account there must be added operating costs and business expenses.

Also, opportunities for vast storage reservoirs have been tabulated and their great potential value pointed out, but with no adequate suggestion as to the feasibility or cost of the dams or the possibility of such gradual silting up of storage space as is experienced on many Southern rivers.

The same glowing accounts fail to discover what use could be made of such vast amounts of power in these remote localities and they utterly ignore questions of market in reckoning value.

Ridicule and distrust are the proper reward for those

who put forth these unqualified statements. True, there are processes coming over the horizon for deriving a stock of nitrogenous fertilizer from the air by means of hydro-electric power, and the production of tool steel, perhaps twice as good as the best that our arts yet know, from the electrical furnace, and we have foundations for a faith that electro-chemistry has other wonders in store; but these uses are yet here only in small degree.

Let us have less rhetoric and more precise engineering investigation in estimating the extent and value of these great resources.

PRACTICABLE WATER-POWER CONSERVATION METHODS.—The plan of action which will accomplish more good in water-power conservation than any other of which I can now conceive is that adopted by New York State two years ago under the wise initiative of Governor Hughes, and carried out by the State Water Supply Commission. According to this, each state should collect the facts regarding each of the notable opportunities for power development within its borders, select the important ones for survey in detail after careful reconnaisance, prepare an outline plan for each, with all the detail that would be required in the preliminary studies for actual development, with full estimates of cost of plant and of amount of power available in different seasons of the year, and make these facts all matters of permanent public record, printed and widely distributed. In these surveys the conservation idea should have full sway; measuring up the full engineering opportunity, with dams planned at the highest level and tail races at the very lowest level that the topography will reasonably permit, and with storage reservoirs of the greatest height and area for which nature has provided a reasonable location, up to the full measure of reasonable flood control.

Every noteworthy opportunity for power development that will ever exist within the state can thus be soon placed on the map, and there will never be a more advantageous time than the present to thus take account of stock, so that public and promoter can see just what degree of promise there is in each opportunity.

The state can perhaps wisely go farther than heretofore and at some of the great sites itself construct the main works, much as the United States Reclamation Service has built reservoirs and canals, or it can invite private capital, through the removal of restrictive laws like those which now forbid storage reservoirs in the Adirondacks, or by laws helpful in bringing the full natural opportunity of one proper site under one control, like the "Mill Acts" and "Flowage Acts" of some of the states. According to conditions found, the state may in one case properly levy a special tax on the power produced, or in another case may best permit exemption from local taxation for a term of years, and in view of the limited number of these opportunities it should be the aim of the state to safeguard the future against extortion through monopoly. There is already manifest in some parts of the country a tendency, under the new conditions of electrical transmission, for all of the power companies in a district to get together in a sort of trust and this may be followed later by rates not primarily intended to foster local industry.

CONSERVATION OF THE PURITY OF WATER COURSES.—This, like the relation of timber cutting to stream flow, is a subject on which it is time for the engineer to interpose a word of caution in regard to some of the well meant talk that has been expended on this subject, which in conserving water seems to completely disregard the counterbalancing idea of conservation of capital.

It is of first importance to arrive at a good sense of proportion in this matter, and to find, for various conditions, just what should be regarded as pollution, and it is important in following ideals not to take leave of common sense. The true criterion plainly is that no refuse should be discharged into a stream which can do harm or cause offense in any important degree. It involves economic waste to set up standards of such purity as is needed for drinking water upon streams that can be given their greatest use as drainage channels.

Flowing water, and quiet water in greater degree, have the power of digesting and rendering harmless very considerable quantities of street wash, and even of sewage, somewhat as the soil of our gardens renders harmless the manure applied; and, within limits, it is reasonable and proper to utilize the rivers as carriers or disposal agents and thereby conserve the funds which some small community can spend to its betterment in other ways. Some industrial wastes are thus digestible; others, like liquor from gas works, are not. Some, if first subjected to a rough straining, or to brief detention favorable for bacterial action may, under scientific oversight, be safely discharged into the natural drainage channels of the region. Others, like the washings from wool scourings, if in too large proportion will foul a water course most offensively, or, if it is discharged into a stream that soon mingles with the salt water of the sea, may become precipitated and cover the bottom with a filthy slime.

The true problem of conservation is to study faithfully and patiently the needs of individual cases in the light of modern science and learn how and to what extent the desired disposal can be carried on without harm or offense.

The engineer is year by year coming into a more important relation to the public as its trusted guide on some of its larger matters of welfare, and in order to maintain this confidence and gain still greater opportunity for doing good, he must not join in the shouting until he has studied into the merits of both sides of the case and must then be steadfast to common sense and to the truth.

CONSERVATION FOR IRRIGATION.—On this subject I have only time to say that no grander example of the conservation idea can be found than in the steadfast work of the past eight years of the U. S. Reclamation Service. Grand in conception, scientific in plan, faithful in execution, the world may be challenged to show public service of a higher order. I would that we might have hung in this engineering hall a painting by a worthy artist, of Newell, Davis and their steadfaster supporter, Roosevelt, and their aids, as in conference, with a background symbolic of the work, which should show to posterity how these men are honored by engineers.

Recognition should be given also to the work of their contemporaries of the state agricultural experiment stations in showing how water saved from floods can be most wisely expended, and how one acre foot, or less, of water can do the work formerly done by two. The recent call from Australia to our fellow member, Mr. Elwood Mead, to come over and help them, is a worthy tribute to the high standards that this branch of conservation has attained in our land.

How remarkable the progress of the past ten years! And how full of significance is the change to the community of interest idea and the development away from the wasteful methods and individual efforts of the early settler, who in many cases spoiled the chance for something better by his crudeness of lay-out, or rendered ground soggy by appropriating more water than his need, or from lack of storage was without reserve for the days when the crop needed it most.

We have passed pretty nearly through the days of unwarrantable promotions, of ditches and farms laid out on a scale for which water could be furnished less than one year in three, and of non-resident ownership in the reservoir and canal, and have arrived at the much better economic conditions of companies in which every shareholder farms his own ground. One development is following another so fast that irrigation bids fair to become within the next decade almost one of the exact sciences, and the spirit of progress and the idea of conservation of water are now so active in the field of irrigation that the call for missionaries is not loud.

CLEARING POWER RESERVOIR SITES.—The scenic value of water has received too scant attention in the work of the engineer, but it is at the hands of the lumbermen and the early mill builders that it has suffered most. The dismal swamps, and the ghostly ruins of trees that were killed by dam building in the Adirondacks and in northern Maine have made such raw spots in the memories of those of us who love the forest and its lakes, that we sympathize with the purpose of the constitutional restrictions which this State of New York has interposed against the flooding of its forest lands by storage reservoirs.

The same object, however, can be attained in a better way by reasonable laws and restrictions governing the clearing of lands that are to be flowed and the elevation below which the lake to be created shall not be drained, and one of the taxes that any state may rightly impose upon water-power development is the proper clearing of lands to be flowed for storage reservoirs and a limitation as to the extent to which the bed of such reservoirs may be uncovered. A rigid standard may well be set. Stumps should not be left to protrude or to wreck boats as the water is lowered, and the clearing to a contour say 2 or 3 ft. above and 10 to 20 ft. outside the highest flow line will seldom impose a burden that the storage benefits cannot reasonably bear.

An artificial storage lake will commonly be found a more beautiful and more wholesome feature in the landscape than a swamp, and in most of our northern regions where these would be built, the wave action will soon prepare a sandy beach along much of the shore line of the broader portions.

Conservation by Legislation.

Dr. Rossiter W. Raymond, Secretary of the American Institute of Mining Engineers, in his paper said that the general awakening of public interest in the conservation of national resources should gratify engineers since it is a topic to some aspects of which engineers have been for a generation calling attention with little result.

True conservation, said Dr. Raymond, lies in the diminution not of use but of waste. So long as ores, timber and other natural resources were available in lavish abundance, lavish use and waste in the exploitation was and is inevitable, and he believes no legislation would be able to prevent it.

The simple and adequate remedies are pressure of economic conditions and the diffusion knowledge. Without arguing as to the proper limit of the functions of government, or pronouncing the validity of the ingenious distinction annunciated by Dr. Lyman Abbott, between a "paternal" government (which is traditionally a bad thing), and a "fraternal" government, which is a good thing. I may say frankly that of all the extra-governmental functions of the people by the spread of information is the most beneficial, the most potent, and the most objectionable. Yet it is a mighty power, the exercise of which, under a representative democracy like ours, needs to be watched. For "government information" is clothed to the public eye with a special authority, which it ought to deserve.

Such information ought to be: (1) collected with care, and not in a hurry; (2) stated without bias or argument in favor of this or that measure or policy; and made accessible to all who desire it by the wasteful and inadequate system of giving members of Congress so many copies per capita, but by printing, in successive editions, if need be, as many copies as individual citizens are ready to buy at cost.

In illustrating how hasty and unwise legislation may injure instead of benefiting the cause of conservation, Dr. Raymond instanced the constitutional prohibition by New York State of all cutting of timber on the State Forest Reserve, and said:

The constitutional prohibition of all cutting of timber on the State Forest Reserve has directly stimulated the setting of fires on that domain. The private owners of large timber-tracts have long been aware that Indians and squatters deem it legitimate to start fires in the woods, for the sake of the subsequent new under-growth, which will furnish good food for cattle. Possible conscientious scruples on the part of the incendiaries are largely quieted by the argument that the woods are not specially valued by their owners, because they are not guarded. In this respect, the U. S. Forestry Bureau has wrought a great public benefit, by simply showing that the United States thinks its forests worth protecting. And this proof is mightily enforced by its actual utilization of the forest-products. But the State of New York, through its Constitution, practically blazons the foundaries of its Forest Reserve with the notice: "The timber on these lands is never going to be used!" Is it any wonder that people should think there is little harm in hastening somewhat the natural destruction to which it has been thus doomed by law?

But unfortunately the hypothetical notice I have quoted carries, in practice, a portentous postscript, substantially saying that while the State will neither cut, on its own account, nor sell to purchasers the right to cut any timber on the Forest Reserve, yet burnt and fallen timber may be removed! Could there be a more fatally seductive temptation to incendiaries? In fact, apart from the unlawful character of the act itself, the perpetrator of it might easily convince himself that he was thereby doing the only thing which the folly of the legislators had left to be done for the stoppage of irreparable waste of the natural resources of the State—namely, converting them by partial combustion into the only form in which they could be legally utilized!

Meanwhile, a State Commission has gone on adding by purchase or otherwise to the Forest Reserve. But since the Constitution forbids the subsequent cutting and sale of timber from any tracts thus purchased, after the title has passed to the State, the Commission cannot afford to buy timber-lands at prices including any value assigned to the timber. Consequently, it bargains for such lands, to be delivered to the State after the timber has been cut off, within a limited period, by the present owners. And the present owners, unless they happen to be within market-distance of a wicked pulp-mill, cut the salable timber as fast as they can, and turn over to the State the land with the unsalable underbrush, tops, branches and twigs of the forest—an ideal nursery of forest-conflagrations.

The final result of all these attempts at conservation by legislation was exhibited last year, when the City of New York was darkened for many days by the smoke of hundreds of square miles from the burning of that Adirondack wilderness which had been prepared by ignorant legislation to nourish just such a bonfire.

Dr. Raymond then took up the question of Federal legislation and showed how inadequate had been the work of Congress in dealing with such matters as mineral land laws and the survey of the public mineral lands, and concluded as follows:

So far as the mineral resources of the country are concerned, I think the immediate duty of American mining engineers is to urge upon Congress the survey of the public mineral lands, and the enactment of a statute making the simple and reasonable requirement that notices of location shall be filed in a U. S. Land Office within a certain period after the act of location. If there is not virtue and intelligence enough in Congress to take this obvious, necessary step, how can we trust that body, or its executive agents, to manage greater questions?

The Waste of Natural Resources Due to Fire.

By CHARLES WHITING BAKER.

The topic assigned to me this evening is in more senses than one a "burning" subject. I know that statistics are apt to be dry, and statistics of fires naturally would be dry in every way. But I have to ask your attention to a few statistics of the waste due to fires.

The United States Geological Survey has been for some time engaged in an investigation of the losses by fire in the United States. Through the courtesy of Mr. Herbert M. Wilson of the Survey, I am able to give you some of the main results of this investigation which have not yet been published.

The sum total of the losses by fire in the United States in the year 1907 was $215,000,000. About half of this $215,000,000 was loss upon the buildings themselves which were burned or injured by fire. The other half was upon the furniture, merchandise, etc., contained in the buildings. Besides this vast property loss there were 1,450 persons who lost their lives in fires and 5,650 were injured. The fires which caused these losses of life and property occurred in 165,250 buildings and the average damage to each building and its contents was $1,667.

Notice that these are the direct losses only. No estimate has been made of the indirect cost of fires, the interruption to business, the expense of maintaining fire departments and of conducting fire insurance companies which distribute the loss generally over the community. Also, these figures include only damages to buildings and their contents. There are, besides, the damages done by fires in mines and in forests to be taken into account to obtain the full record of destruction due to this element.

Let us come back, however, to these figures of total loss by fires in buildings in 1907. What do these figures mean? Do we really comprehend their significance? We speak glibly of a million or a hundred million or two hundred million, but do these figures really create a vivid picture in our minds?

I strongly suspect that we, as engineers, too often handle statistics and numbers and records without clearly comprehending how much—or how little—they mean. We handle them quite as the engineering student sometimes handles his problems in algebra or mechanics—X and Y and C′ are just letters to him. He forgets that they symbolize actual concrete quantities. So we forget in dealing with large figures to visualize the bulk they represent.

Suppose we try and picture to ourselves what these many millions of dollars worth of valuable buildings in which fire annually rages would look like. Suppose it were possible to bring these buildings which were visited by fire in 1907 all together and to range them on both sides of a long city street. Let us place these buildings closely together as they might be placed on an ordinary street in a fair sized city. We will assume that the lots on which these buildings stand have an average frontage of 65 ft. How long a street do you suppose would be required to make room for all these buildings? Make a mental guess in your mind before I tell you and you will then have some idea how accurate your conception of large numbers is. Perhaps you may guess that such a street would reach the length of Manhattan Island; or you may be bolder and guess that it would reach from New York all the way across New Jersey to Philadelphia. But those of you who are apt in that most useful branch of mathematics to the engineer—mental arithmetic—have perceived already, I doubt not, that the street will be far longer than this. I may say at once that this street, lined on both sides with the buildings visited by fire in 1907, would reach all the way from New York to Chicago.

That is what the annual fire loss of the United States represents—a closely built-up street a thousand miles long with every structure in it ravaged by the destructive element. Picture to yourself driving along this terribly desolated street. At every thousand feet you pass the ruins of a building from which an injured person was rescued. Every three-quarters of a mile there is the blackened wreck of a house in which some one was burned to death.

Imagine this street before the fire touched it, lined with houses, stores, factories, barns, schools, churches. Suppose the fire starts at one end of the street on the first day of January and is steadily driven forward by a high wind, just as actually happens in a conflagration. Building after building takes fire; and while the fire fighters save some in a more or less injured condition, the fire steadily eats its way forward at the rate of nearly three miles a day, for a whole week, for a whole month, for all the twelve months of the year. And at the end of 1907 did the conflagration end? No; it began on a new street a thousand miles long which was likewise destroyed when 1908 was ended. And this same destruction is going on to-day.

But you say, do not the figures you have quoted represent an unusually bad year? And are not the improvements in construction, the better building laws, the better fire protection, showing in diminished fire losses? Unfortunately I have to answer No to both these questions. The statistics of fire losses gathered for many years by the National Board of Fire Underwriters show that the annual fire loss has been steadily increasing. In the ten years ending with 1907, the annual fire loss averaged $203,000,000. In the ten years ending with 1897 it was $132,000,000. In the ten years ending with 1887 it was $92,000,000. Thus our fire loss has doubled in 20 years. Of course, the increase in population, in wealth, in number of buildings, mean that more property and lives are at risk from fires and accounts for the increase in total fire losses that the past 30 years has shown. But that increase has not been noticeably checked by anything which we have done to reduce the fire risk.

But again you say, is not this fire loss a necessary evil? Must not a certain risk of fire be incurred in any building? Is there anything to show that the total fire loss, the risk to property and to life can be reduced?

These are fair questions and their answer may lead us to take what I may call a common-sense view of the subject. A certain amount of loss by fire must be expected. Safety and danger are relative terms, and there is no such thing as absolute safety. But we have only to look at the records of fires in European countries to learn that our fire losses are very, very far beyond those of any other country of advanced civilization. The fire loss in the United States in 1907 represented an annual per capita tax of $2.50 on every man, woman and child in the population. That means a tax of $15 a year on the head of every family of six persons. In the principal European countries the fire loss per capita per annum is as follows: Italy, 12 cts.; France, 30 cts.; Austria, 29 cts.; Germany, 49 cts. Allowing for the fact that European populations are far more dense than our own, it is yet evident that their losses are only a small fraction of those in the United States. It is only in Russia and Norway, where wooden buildings form a considerable proportion of the whole that the fire loss per capita approaches even half of our own per capita rate.

I have referred to a common-sense way to treat this question of fire risk. It seems to me that the common-sense way is to reduce fire risk by better construction whenever and wherever it will pay to do so. The engineer's business is to make a dollar earn the most interest. If a structure will represent a smaller annual cost for its whole life, insurance and fire risk taken into account, when built of wood than when built of iron or brick, or stone or concrete, then and there wood is the material to use. Deplore as we may the loss of the forests, the engineer, like every one else, is hemmed in by economic laws and market prices and cannot stray far from the bounds that they set or he will find his occupation gone.

But—and this is a big but—the trouble is that the public—and the engineers with it—is apt to run on in a rut. We go on building in the old-fashioned way because it *was* the cheapest once and are not wise enough to realize the economy of newer methods. Nothing but high and higher prices for lumber will bring us to our senses and induce us to wake up and bring ourselves and our practice up to date.

I said, you remember, use better construction whenever and wherever it will pay to do so. I use that word "pay" in a very broad sense. It may pay the builder or the owner best to put up a cheap building, which will be a danger to tenants and a menace to all adjacent buildings. A hundred or a thousand such buildings huddled in a city make the possibility of a conflagration. Thus comes about the necessity of laws to regulate building. We have erred in the past and still err all over this broad land, because we have laid over-much emphasis on the right of each individual to do as he pleased with his own. And we have been slow to realize that this liberty often degenerates into license to do as he pleased with the rights and the property of his neighbors.

I do not overstate the case when I say that our American cities and villages are made up almost wholly of fire trap buildings. We have lagged far behind in our adoption of better and safer methods of building construction. We must for at least a generation to come pay the penalty of heavy charges for fire protection, heavy insurance rates, heavy fire losses. And we must continue to bear this heavy tax until we rebuild our cities with fire-resisting structures.

Fortunately the engineer has provided the means and the materials by which better and more economical construction can be substituted. It was the circular saw and the railway that created cheap timber throughout the 19th century and housed the people of the United States in cheaply built and easily burned wooden buildings. It is the rotary kiln for burning Portland cement, the rock drill, the brick press and a thousand other modern inventions that are to create the incombustible buildings which the 20th century is to construct.

Let us not forget, either, that incombustible buildings are only one part of the art of fire protection engineering. Most of the materials of commerce are combustible. Many are highly inflammable. We must protect the contents of warehouses and factories, even though the structures be safe.

I know of no better proof of the possibilities in the field of fire prevention than what has been actually accomplished by the Factory Mutual Insurance companies of New England. These companies, insuring chiefly mills which handle cotton, one of the most inflammable of materials, have reduced their rate of loss to about 5 cts. per annum per $100 insured, a rate of loss little more than a tenth, probably, of the average fire loss on all classes of buildings in the United States. I cannot refrain from saying that among the pioneers who have done most in accomplishing this feat in conservation—in the prevention of waste—is the first speaker of this evening—Mr. John R. Freeman.

The automatic sprinkler, the automatic fire alarm and many other devices, with the organization and discipline of fire fighting forces, and inspection for fire prevention, have transformed one of the most dangerous classes of fire risks to one of the safest.

I remember my old professor of rhetoric telling me that a model sermon should be like a kiss—two heads and an application.

My sermon on this burning question must draw to a close, but I must say just a word under my second head, which is forest fires. I will not bore you with many statistics of forest fire losses. Surely, surely the memory of the forest fires which raged last September and October and of the vast losses of property and the terrible losses of life that then occurred is too near and too vivid to need more than a passing allusion.

The fires which raged in the Adirondack region last fall burned over an area of 347,000 acres or 542 square miles. About 38% of this area bore merchantable timber. This damage was done within the limits of one single state. I leave you to form your own estimate of the value destroyed by these fires and by the multitude of other fires which raged through New England, in Pennsylvania, in the pine forests of Wisconsin and Michigan and Minnesota and in the Southern States.

And the worst result of the forest fire—even worse than the destruction of valuable timber and young growing trees which should furnish the lumber that will be so sorely needed a quarter century hence—is the destruction of the soil itself. There are many hundreds of square miles in the Adirondack region where forest fires have burned away the wood soil and humus and have destroyed the possibility of reproducing the forest growth—at least for long years to come. Is it a light thing that these vast areas, which might under proper administration go on producing year after year a steady crop of timber, should be reduced to barren desert?

What I most want to make clear to you is that unless and until you create in every forest state of the Union effective laws and effective organizations to prevent forest fires—unless and until you do that thing—all our talk of conserving the forests is vain. We cannot get away from economic laws. We cannot expect a man to preserve valuable woodlands uncut when a forest fire may at any time wipe out the property entirely. And the higher the price of lumber goes, the greater the inducement to cut off the trees.

Thus the more our forest dwindles and the nearer the inevitable timber famine approaches the more certain we make it that all the forests shall disappear. If a man could hold his timberlands like other property for a higher price without risk of total loss, many would prefer to do this and many would be found to undertake timber culture; but, so long as timber properties are subject to grave risk of total loss, they cannot be attractive to capital.

Some one may criticize that I have said very little so far about conservation. But surely little need be said to prove that the fire loss is a waste and a vast drain upon our natural resources. Every one appreciates it, of course, where forest fires are concerned; but it is just as much of a drain on the forests to burn up the boards and the timber in a house which must be rebuilt as to burn up the trees before they are cut down and sawed. And not only timber but iron, tin, lead, zinc—all the materials used in building construction and a vast amount of merchandise contained in buildings is devoured annually by the flames. Surely, then—the prevention of this waste—the work of the structural engineer and the fire protection engineer—is a task whose accomplishment means much for the public benefit, means much for the conservation of the world's resources.

Electricity and the Conservation of Power.

By L. B. STILLWELL.

General statements from sources commanding the attention and arousing the interest of the public are necessary first steps in turning a nation from reckless waste and almost unrestricted appropriation of natural resources by individuals to a policy of wise conservation, having due regard to the common interest now and in the future. Those first steps have been taken, on the whole, in an admirable manner. Public attention has been arrested. Public interest has been aroused. Public and legislative opinion are forming. Obviously it is of the utmost importance that our engineering societies should take an immediate and active part in working out the complex problems of conservation and, if possible, di-

recting the formation of public opinion along lines that shall result in the enactment of just and wise laws.

The part which electricity is destined to play in the conservation of our energy resources is demonstrated clearly by what it already has accomplished. Three typical illustrations will suffice: (1) the saving of coal by utilization of water power, as illustrated by the plants of the Niagara Falls Power Co.; (2) the saving of coal by substitution of large and highly efficient steam plants for smaller and less efficient plants, as in the case of the Newcastle-upon-Tyne Electric Supply Co.; (3) the saving of coal used for transportation purposes by substitution of large and highly efficient engine units for comparatively small and inefficient locomotive units, as accomplished, for example, by the Interborough Rapid Transit Co., of New York.

* * * * * * *

During the year 1908, the plants of the Niagara Falls Power Co. delivered an output of 560,000,000 KW.-hrs. Had this output been generated by large modern central stations using steam power, their consumption of coal would have approximated 2,000 tons per day. Were the users of Niagara power dependent to-day upon their own individual steam plants, they would use in the aggregate not less than 3,000 tons of coal per day; in other words, more than 1,000,000 tons per annum. If this power were replacing steam, as used under average conditions in our manufacturing cities, instead of being used for the most part in supplying power to comparatively small number of customers using large blocks of power, it would replace and save nearly 2,000,000 tons of coal per annum.

The Northeast Coast Power System, supplying electric power to the great industrial district in and about Newcastle-upon-Tyne, effects a very important economy in coal consumption. In a paper presented at the Middlesbrough meeting of the British Iron and Steel Institute, in 1908, Mr. Chas. H. Merz, the engineer under whose able direction this large enterprise has been carried out, shows that the economies resulting from centralization of power development and electric distribution have led to the construction of plants now in operation aggregating 102,000 HP. installed, and that additional plant aggregating 34,600 HP. is under construction.

Not only has Mr. Merz established highly successful steam-driven power plants in a district where the cost of coal ranges from 7s. to 9s. per ton, but he has demonstrated that important economy of coal consumption results from the supply of electric power to the collieries for their mining operations.

Apart from the efficient utilization of waste heat, apart from the saving of coal in ship-building and engineering works, and apart from the saving resulting from the electrification of railways, the application of electricity to coal mines in this district, when as complete as that to the Tyne shipyards, will render available for outside sale over 1,750,000 tons of coal.

The output of the power-house of the Interborough Rapid Transit Co., New York, for the year 1908, was 409,000,000 KW.-hrs. The consumption of coal was 494,000 tons. In a paper presented at the 214th meeting of the American Institute of Electrical Engineers, by the writer and Mr. H. St. Clair Putnam, comparison was made from the company's operating records of the fuel consumption upon the Manhattan elevated lines during the year ending June 30, 1901, when steam locomotives were employed, and during the year ending June 30, 1904, when electricity was used. I quote from this paper:

> Referring to the period first mentioned, one pound of coal produced 2.23 ton-miles, if the weight of the locomotive be included, and 1.5 ton-miles if the weight of the cars only be considered.
>
> During the latter period (electric traction), one pound of coal burned at the power-house produced 3.85 ton-miles; excluding weight of locomotives, therefore, the ratio of ton-mileage per pound of coal in favor of electric operation was 2.57 to 1. Including weight of locomotive it was 1.72 to 1.
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> The average speed under electric operation was approximately 2 miles an hour greater than that attained by steam, and if correction be made for this difference, the ratio of ton-mileage per pound of coal, excluding weight of locomotives, is approximately 3 to 1, and including locomotives 2 to 1 in favor of electric traction.

If, therefore, we can conceive the possibility of operating to-day, by locomotives, the entire service of the elevated and subway lines of the Interborough Co., it appears that the saving in coal consumption effected amounts to not less than 988,000 tons of coal per annum.

Our ability to utilize in the near future a large proportion of our water powers depends primarily upon the distance across which power can be electrically transmitted at practicable costs. This in turn depends upon the limits of potential against which transmission lines can be insulated in a manner which secures reasonable continuity of service. No precise limit of practicable distance can be fixed nor is it necessary here to enter into a detailed discussion of the subject. It is sufficient to point out that power to-day is being transmitted from Niagara Falls to Syracuse, a distance of 160 miles. In California, it has been transmitted successfully a distance exceeding 200 miles. While 200-mile transmission does not bring every water power of the country within reach of an adequate market, it obviously does suffice as regards a very large proportion of our hydraulic resources not as yet utilized.

The report of the Inland Waterways Commission acting as the Section of Waters of the "National Conservation Commission," before the recent Joint Conservation Conference in Washington, states:

> (1) Under average conditions every hydraulic horsepower utilized for industrial purposes in ten-hour service saves at least 7½ net tons of coal per annum; (2) present knowledge does not permit us to secure from coal burned for power purposes, even under conditions of best commercial practice, more than 10% of the energy which it contains and under average conditions less than 5% is utilized; (3) electricity enables us to substitute a few and comparatively efficient steam plants for large numbers of small and relatively wasteful installations; thus effecting important economies not only in fuel consumption but also in other directions. It also enables us to transmit and utilize in available markets a very large proportion of the aggregate water power of our streams.
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> In view of these facts, it will be admitted that from the standpoint of conservation of our power resources, the attitude of the Federal and State governments should be such as will hasten and not retard the development of our water powers. Any policy which operates to retard this utilization is a damage to the community, not only because it tends to increase the average cost of power and, therefore, of transportation and the manifold products of our manufacturing industries, but also because it tends to prolong and even increase the, at present, necessarily wasteful utilization of coal supplies which can never be replaced. Such a policy, therefore, is on its face in direct contravention of the true principles of conservation.
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> Water powers not hitherto approoriated under existing laws belong to the state and unquestionably should be utilized in a manner which will secure the utmost practicable advantage to the community. There is every reason why they should not be appropriated in perpetuity either by individuals or corporations. In permitting their appropriation and use for a limited period, the state undoubtedly should secure the best terms possible, but the fact that prompt utilization means not only a saving of coal resources but a reduction in cost of manufacture and transportation, is a consideration of the utmost weight. As compared with the direct revenue which can be expected to result from levying a direct tax upon water powers, this consideration, from a broad economic standpoint, is in all probability controlling. Doubtless the state can tax water powers and can devote the proceeds of such tax to any special purpose which it may elect, e. g., the construction of inland waterways, as has been proposed, but correct determination of the wisdom or folly of such an arrangement requires careful consideration and at least approximate knowledge of the quantitative values of the economic results to be expected.

In a short speech before the Conference of Governors at the White House in May, 1908, referring to water powers, President Roosevelt said:

> My position has been simply that where a privilege, which may be of untold value in the future to the private individuals granted it, is asked from the Federal Government, that the Federal Government shall put on the grant a condition that it shall not be a grant in perpetuity. Make the term long enough so that the corporation shall have an ample material reward. The corporation deserves it. Give an ample reward to the captain of industry but not an indeterminate reward. Put in a provision that will enable our children at the end of a certain specified period to say what in their judgment should be done with that great natural value which is of use to the grantee only because the people as a whole allow him to use it. It is eminently right that he should be allowed to make ample profit from his development of it, but make him pay something for the privilege, and make the grant for a fixed period, so that when conditions change, as in all probability they will change, our children—the Nation of the future—shall have the right to determine the conditions under which that privilege shall then be enjoyed.

With the ideas thus vigorously expressed, every good American citizen must be in sympathy. To the admirable exposition of principles included in the preliminary report of the Inland Waterways Commission, dated Feb. 26, 1908, few engineers will take exception. But the attitude of many of the speakers at the recent Conservation Conference in Washington, upon the occasion of the second gathering of the governors of the States, clearly evidenced a disposition to beg one of the fundamental questions, which arises at the very threshold of consideration of the utilization of our streams; namely, the question of the real economic value of inland waterways. The minds of some who are taking an active part in the discussion of this great economic question apparently start with two assumptions: (1) that the economic value of a vast system of inland waterways is admittedly so great as to justify practically any expenditure in its development; (2) that the water powers upon our streams are inexhaustible mines of wealth capable of yielding, under a general system of taxation, large revenues. From these premises the conclusion that water powers should be taxed to pay for waterways is easily deduced.

To the engineer it is evident at once that before any conclusion, involving expenditure of large amounts either of public money or private capital is agreed to both premises upon which that conclusion is based should be critically examined.

In considering the proposition to [illegible]se a general tax upon water powers and devote the [illegible]roceeds of this tax to the construction of a system of [illegible]nd waterways, it is clear that the first effect of such [illegible] tax is to retard the development of water powers [illegible]es some compensating advantage is offered. It is [illegible] evident that such a tax operates indirectly to sti[illegible]ate the consumption of coal and that if it be dec[illegible] that we can afford to tax manufactures indirectly [illegible] order to improve transportation facilities it would [illegible] wiser, from the standpoint of conservation of our [illegible]er resources, to impose a tax upon coal used for po[illegible] purposes. A tax of $3 per HP. ($4 per KW.) per ann[illegible] is equivalent to a tax of 40 cts. a ton (2,000 lbs.) [illegible]oal used for power purposes in manufacturing, if we [illegible]sume that 5 lbs. of coal per HP.hr. are used. A pro[illegible]al to impose any such tax on coal used for power pu[illegible]oses and use the proceeds for the construction of in[illegible]d waterways probably would command little influenti[illegible] support and yet a similar proposal, as applied to wa[illegible] powers, has received weighty endorsement and appare[illegible]ly is highly approved by those who are especially interested in the development and extension of inland waterways.

It would be impossible to suggest a mo[illegible] fruitful subject for unprejudiced analysis and illuminating exposition by competent members of our national engineering societies, in the immediate future, than the comparative economic advantages of railways and inland waterways. Facts in this field are urgently needed and should be supplied before public sentiment, unenlightened by unbiased competent advice, and influenced, perhaps, by prejudice and the clamor of local interests, shall crystalize in legislative enactment or executive rulings.

Within the last two years, my firm, in considering problems presented by the substitution of electricity for steam in railway operation, has carefully studied the cost of operation of steam railways in the United States, using as the basis of this investigation not only the valuable reports of the Interstate Commerce Commission but also detailed operating cost sheets confidentially furnished for the purpose by a number of the most important railways in the country. It also happens that within the same period we have had occasion to determine with great care the actual cost of operation of one important canal system and in this connection have secured considerable information bearing upon the general question of the economics of canal transportation. The conclusions which we have reached as a result of these comparative investigations do not support broadly and without material qualifications the popular impression that transportation of freight by inland waterways, in general, is less expensive than transportation by railways.

Obviously if we begin by assuming that because freight is carried across the Atlantic or through the Great Lakes at less cost per ton-mile than it is carried by our railways, an increase in the depth of channel or improved regularity of flow of any given inland stream will secure corresponding results, we shall be misled and expenditures based upon any such assumption will be wholly or largely wasted. Each case should be studied and competently studied on its own merits. To tax water powers for the purpose of providing free waterways, from a broad economic standpoint, is a policy which, before adoption, should be compared carefully with the plan of imposing tolls upon all users of inland waterways and using the proceeds to develop water powers and secure cheaper power for our manufacturing industries.

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In the preliminary report of the Inland Waterways Commission, dated Feb. 26, 1908, I find the following:

> While navigation of the inland waterways declined with the increase in rail transportation during the latter decades of the past century, it has become clear that the time is at hand for restoring and developing such inland navigation and water transportation as upon expert examination may appear to confer a benefit commensurate with the cost, to be utilized both independently and as a necessary adjunct to rail transportation.

The fundamental facts here set forth will receive the unanimous and enthusiastic endorsement of the entire engineering profession. In determining, however, how the admirable and vastly important objects in view are to be attained every engineer should use his best endeavors to prevent fundamental and far-reaching mistakes which easily may result from action based upon insufficient or inaccurate knowledge.

RAILWAY ACCIDENT STATISTICS FOR CANADA issued by the Department of Railways and Canals include the following figures for the year 1907-8:

	Killed.	Hurt.
Passengers	28	345
Employees	224	1,738
Trespassers	150	120
Non-trespassers	22	59
Postal and express men	16	3
Other persons	9	27
Total	449	2,347

These statistics cover 23,000 miles of railways. One passenger was fatally hurt for every 1,215,[illegible]83 carried and one less seriously injured for every 98,[illegible]91 carried.

Report of the Boston Metropolitan Improvement Commission.

A report dealing in a broad and comprehensive manner with many of the problems confronting the 39 cities and towns composing the Boston Metropolitan District has been submitted to the Legislature by a legislative commission appointed in 1907. The Commission was given almost unlimited powers of investigation, but particular stress was laid upon transportation problems, including the highways of the Metropolitan District. The studies of the Commission, as well as the apparent consensus of public opinion, led it to concentrate its work upon the transportation and highway problems. Inasmuch as almost every one who expressed an opinion seemed deeply concerned for the future of Boston as a commercial port, particular attention was given to that subject.

The act creating this Commission was published in full in our issue of Aug. 8, 1907 (p. 152). The members of the Commission and the professional or other interests which they represented, were as follows: Law, Mr. Benjamin N. Johnson, of Johnson, Clapp & Underwood, Boston, Mass.; Architecture, Mr. Robert S. Peabody, of Peabody & Stearns, Boston, Mass.; Finance, Mr. Henry B. Day, of R. L. Day & Co., Boston, Mass.; Transportation, Mr. Thomas J. Gargan, Rapid Transit Commission, Boston, Mass.; Engineering, Mr. Desmond FitzGerald, M. Am. Soc. C. E., Brookline, Mass. Mr. Johnson was Chairman of the Commission. Mr. Sylvester Baxter served as Secretary.

Two members of the Commission made somewhat extensive studies abroad. Mr. Peabody, the architect member, devoted a portion of the year 1907 to municipal and port improvements in the leading European cities. The results of his studies were published in pamphlet form by the Boston Society of Architects. In the summer of 1908, Mr. FitzGerald devoted a number of weeks to the study of port conditions in European cities. Mr. Gargan, who was eminently fitted for work on the Commission by his long and efficient period of service on the Boston Transit Commission, expected to have made foreign studies while abroad in 1908, but died in Berlin on July 30 of that year.

In addition to the studies made by the Commissioners, investigations and reports were made as follows: Mr. George R. Wadsworth, Assoc. M. Am. Soc. C. E., took up the steam railroad systems and their terminals within the district; Mr. Arthur A. Shurtleff, landscape architect, considered highway communication, and Mr. Richard A. Hale, M. Am. Soc. C. E., took up the subject of artificial waterways or canals in their possible relation to the commerce of the port of Boston.

Among the recommendations of the Commission are: extensive improvements of freight terminal facilities by the relocation of the Boston & Maine yards, the establishment of receiving and clearing yards at various points, the development and extension of the present connecting freight railroads, the establishment of a system of car floats between harbor terminals, and the provision of additional local-delivery freight yards. Improvements to the passenger terminals suggested include the electrification of steam railway lines in the district, the reconstruction of the north and south railway passenger stations, the construction of a four-track tunnel between these stations and of a subsurface station on the tunnel line in the market district, and a tunnel beneath the harbor for the Boston, Revere Beach & Lynn Ry., with a loop connecting with the proposed market station. The recommendations for improved water transportation facilities include the establishment of a free dock at East Boston and the reservation of lands in Boston Harbor for possible inner dock and harbor facilities.

The introductory portion of the report consists largely of a general review of problems relating to the future of the Metropolitan District. The Commission points out that Boston and vicinity are unusually dependent upon the expedition and economy with which transportation is effected. The raw material for our great manufacturing industries is in the main brought from a distance. Practically no part of it is produced on our own soil. Again, an overwhelming percentage of the finished product of these industries is shipped out of New England to the ports and cities of the world. * * * Under modern conditions excessive cost of transportation is likely to be found in charges for handling and transfer rather than in those for carriage. * * * Every saving in such local charges will correspondingly extend the radius within which Massachusetts may successfully compete with other states or countries.

The "excellent harbor" of Boston is its "foremost commercial asset." The tonnage of the city is second only to New York, but "its real competition as a North Atlantic port is hereafter to be not so much with New York as with Montreal, Philadelphia and Baltimore." Boston "is 180 miles nearer the great ports of Europe than any other leading North Atlantic port."

The Terminal Problem.

The report lays great and proper stress upon the fact that the transportation problem at Boston and vicinity is essentially a terminal problem. It says:

The existing terminal facilities of Boston, considering the needs of the present, as well as of the future, are inadequate. This is true alike of its railroad and water terminals. The present railroad freight terminals, in their lack of efficient connection, are the natural survival of the days when Boston had eight separate and independent railroads entering the city. They require radical improvement if the future commercial opportunities of Boston are to be met. The water terminals are mainly owned and controlled by the railroads and other transportation lines. They are already becoming congested to the point of interfering with the dispatch and economy of business, and are in no way comparable in their arrangements and facilities with those of many other cities of less commercial importance.

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Greater Boston, being in effect one terminal district, the proper improvement and development of its terminal facilities should be treated as a single problem. The present arrangement of separate and independent freight terminals for the several railroads and lines of water transportation should be abandoned, and in its place there should be adopted a comprehensive plan for a flexible and efficient system of interchange terminals, whereby commodities, whether in carload or cargo bulk, or in lesser lots, may be delivered and transshipped from railroad to railroad, or from land to water, or vice versa, and distributed among consignees, with the highest attainable expedition and economy. The establishment of such a system of interchange terminals is of the greatest importance to Boston. The controlling features of such a system should be direct and effective connection between all lines of railroad entering the city and every portion of the terminal system, as well as access to and use of the system and its facilities by every railroad on equal terms for like service.

Such a system necessarily involves some well-considered plan of water terminal improvement. Boston for many years has been without any definite plan for comprehensive harbor development or for the correlation and efficient connection of its terminals.

With a few notable exceptions, the wharves and docks of Boston are of insufficient length to accommodate steamships of the size and type now coming into general use. The wharf sheds are mostly of wooden construction, inviting frequent conflagration. Not only should the docks be longer and wider, but the piers should be wide enough to afford ample room for streets, warehouses or freight sheds and railroad tracks. It appears very probable that North Atlantic business will soon be done almost entirely by steamships of the combination type, large passenger steamers carrying freight.

Docks that are to be built should be arranged to a considerable extent for the accommodation of passenger business as well as freight business. The very fact that so much passenger business has heretofore come to Boston despite inadequate facilities, demonstrates that better facilities are demanded and that the passenger business under reasonably favorable conditions may be expected to show a large increase.

A belt freight line was considered by the Commission and dismissed as impracticable. Instead, the Commission advises the relocation of the Boston & Maine freight yards, and the development of existing connecting freight railways and yards, and the establishment of a clearing yard. Particular emphasis was laid on the value of the "use of lighters in the transfer of package freight from one water terminal to another."

Passenger Terminal Improvements.

The suggested improvements in the terminal handling of railway passengers have already been briefly outlined. These would bring all passenger trains into the present North and South terminal stations beneath the street level. By running the trains which now stop at each terminal to and beyond the other terminal, an interchange of traffic would be effected as well as improved facilities for shifting and reversing trains, besides landing such passengers as desired it at the proposed intermediate station.

A Terminal Company Under Public Control.

The heavy burden of debt already resting on the Metropolitan District leads the Commission to conclude that the terminal improvements which it recommends should be carried out at private rather than public expense. The Commission states that the present net direct and indirect debt of the cities and towns in the Metropolitan District totals a little over $171,000,000. This is 8.27% of the total assessed value of the district, and the yearly interest and sinking-fund charges on the debt nearly equal 23% of the total yearly running expense of the several municipalities.

The Commission undertook no estimate of the cost of the various improvements which it proposes. This and the formulation of the details of any workable plan would require extensive engineering investigations, including careful detailed estimates of cost. The Commission suggests that the Legislature commit these studies to another commission. It continues:

When at length, after the final report of such commission, the time shall have arrived for definite action in that regard, the equipment of Boston with a proper system of freight and water terminals, with modern warehouses and port facilities, as well as the reformation of its passenger terminals, should be worked out and completed under public direction. There is probably no practicable alternative. Assuming that such improvements could be carried out by a company projected purely as a private enterprise, the transfer and switching charges which a modern terminal system is designed to eliminate would necessarily be continued by such a company and might thereby become perpetuated. The exaction of such charges from the railroads would inevitably evoke their lasting opposition. On the other hand, action by the railroads themselves on their own initiative, or effective cooperation among them, in so far-reaching a matter is extremely unlikely. This is especially true where there are so many companies owning or operating railroads entering the city.

Public direction with railroad cooperation offers the most promising solution of the problem. But such a plan should be, and if it is to succeed must be, made reasonably attractive to the railroads. No effort should be spared to secure their full cooperation with the public on equitable terms. It is eminently fit that so comprehensive a proposition as that of terminal and harbor development should be carried out by the united action of the public authorities and the railroads. They would enjoy in common the benefits of an increasing commerce and business, with the resulting growth in population and in wealth. They should, therefore, participate in bringing these things to pass.

Bearing this view of the matter in mind, the most feasible method of bringing the present inadequate and ill-connected terminals of Boston into one great modern terminal system would appear to be through a terminal company, to be organized and promoted by the joint action of the public authorities and all the railroad companies. The reconstruction of the passenger terminals and their connection by the proposed tunnel, upon the adoption of that or any similar plan, should be carried out through the instrumentality of the same terminal company. Such terminal company should acquire the terminal properties and sites for terminals now owned by the railroads, with all connecting track lines, so far as they would form an essential or natural part of the proposed terminal system.

Inland Waterways.

Mr. Hale's studies of a possible increase of inland waterway facilities indicated that nothing of the sort is feasible in Massachusetts, with the two possible exceptions of the completion of the Cape Cod canal and the construction of the proposed Brockton-Taunton canal between Fore River and Taunton, Mass.

Water Front and Harbor Developments.

Attention is next given to water-front sites for industrial establishments. The extensive and excellent opportunities for such sites afforded by the Metropolitan District are noted in some detail. The Commission says:

The promoters and managers of New England industries have been too prone in the past to turn their backs upon the signal opportunities thus presented by the water front of Boston Bay. Under modern conditions they are beginning to show a higher appreciation of their value. Many plants have found the ample supply of

water for condensing purposes in itself a sufficient reason for locating upon bays and rivers. Added to this is the recognized value of being able to secure coal and foundry and factory supplies by water transportation. This growing appreciation of the value of a water frontage for industrial plants will soon include the obvious opportunity of water competition with the railroads in the bringing in of all raw materials, and then the use of barges, lighters, coasting vessels, and probably transfer floats, will furnish to factories thus situated all the advantages of being connected with a world-wide system of water transportation.

Reference is made to investigations of harbor improvement possibilities already made by Lynn. The Commission advises that the public should take no additional land along the water fronts for park purposes wherever such taking would "divert any portion of this great water front from its use for commerce and industry." The Commission also recommends "the permanent reservation of certain areas within Boston Harbor for the location of a future system of docks." It speaks approvingly of Mr. FitzGerald's plan for future dock developments. This plan could be "carried out pier by pier, and dock by dock, as the development of commerce and business" might require. Reference is made to the alternative plan of dock development suggested in Mr. Wadsworth's report. This plan includes a "suggestion for the development of an industrial district like the Bush terminal" in Brooklyn. Further reference to Mr. FitzGerald's plan will be made later on.

Rapid Transit.

The Commission expresses regret that it has been unable to reach sufficiently definite conclusions regarding rapid transit development to warrant specific recommendations. It suggests that the study of rapid transit problems should be referred to the Boston Transit Commission, and that enlarged powers should be given to that Commission. Heretofore the Boston Transit Commission

has been, with slight exceptions, a constructing board, bound to follow the plans and system determined upon by the Legislature. The members of our Legislature and of its committees, high as their character, personal qualifications and devotion to the public interest are known to be, do not serve for a sufficient period of time to become experts in so complicated and difficult a subject as that of rapid transit. It is a matter which preeminently requires experience and expert knowledge. The railroad companies concerned in these matters have the benefit of the long service of their officers, and are constantly availing themselves of expert assistance. The public should have the corresponding advantage of being represented in the solution of every transit problem by a body of trained and experienced men, who have given sufficient study to the subject to enable them to reach sound and wise conclusions.

Metropolitan Highways.

A system of main highways for the Metropolitan District has been under consideration since 1904. This subject was one of the few specifically imposed upon the present Commission for investigation. The Commission states that with the assistance of Mr. Shurtleff the matter of highways has been given careful attention, and that the needs of every city and town in the Metropolitan District have been considered. A few paragraphs on highways may be quoted from the report:

Generally speaking, the radial roads connecting Boston with the country are wide and direct and perform a very efficient service for the district. This radial system is not, however,, being reinforced against larger demands. Additional radial roads are not being gradually created, as might be the case if the municipalities were aware of their importance, or if at the instance of some central authority they were obtained as the minor streets are built one by one or foot by foot. Such a gradual realization of an intelligent scheme only calls for a concerted and rational development and need involve no added expense to the district.

The circumferential roads connecting one town with another are many in number and are useful to a certain degree; but they often fail, generally by very small margins, to make connections of the most useful kind.

The failure of the existing cross-district (circumferential) roads thus to accommodate through traffic, tends to congest the main radial thoroughfares, especially in the vicinity of Boston. Traffic which cannot cross the district for want of connecting roads is obliged to go first to Boston upon the nearest radial thoroughfare and then go out again upon another radial leading to the city or town sought.

It is surprising how frequently the lapses in the circumferential highways occur, and yet how readily they might be filled in. Some of these shortcomings need to be made good at once, as, for example, that which prevents a convenient passing from Harvard Bridge northward, either into the park system or to the common highroads in the northern part of the district. There are many minor lapses which need similar attention. By far the greater number of these can be corrected gradually and without extra expense, provided some intelligent foresight is exercised as to the development of local streets with reference to future needs and provided some power to undertake such improvements is duly constituted.

If, on the other hand, things are allowed to continue as they exist to-day the time will come when these connections cannot be achieved without almost prohibitive cost. In short, as the road system of the district is a very admirable one, provided the comparatively few defects in it can be corrected, there appears to be no need of establishing a new general system of intercommunication between the various suburbs or between the suburbs and the city. It is a question more of details than of any radical change. But these details are vital to the situation, and unless the missing links are made good it would be fair to say that the circumferential element in the metropolitan highway system comes near being a very bad one.

In order to avoid the addition of another commission to the 60 Massachusetts state commissions already in existence, the Metropolitan Improvement Commission suggest that the present Metropolitan Park Commission and Metropolitan Water and Sewerage Board be consolidated, and that Metropolitan highways be placed within the jurisdiction of the new board. As many of our readers know, there was originally a Metropolitan board for water and one for sewerage. These were consolidated a few years ago, when the work in both lines had progressed well toward completion. Both the water and sewerage and the park boards have already done a considerable amount of highway construction, and they have comparatively little construction work of any sort in hand at present, their duties being chiefly those pertaining to operation.

Unless some provision is made for carrying out the necessary extension of highways within the district in order to form a true Metropolitan system, it is feared that the work of the Commission now reporting "will be largely wasted." It would not be necessary, however, to execute any of the work immediately. The Metropolitan Improvement Commission suggests that the proposed board having charge of the water, sewerage, park and highway systems of the Metropolitan District be given the benefit of

the cooperation of a council composed of the mayors and chairmen of selectmen of the Metropolitan District. This would in itself be enough to insure the accomplishment of many of the improvements which the Commission recommends, for it is impossible to conceive that these two bodies could assemble for the purpose of considering the needs of the district without having the folly of longer neglecting these subjects irresistibly forced upon them.

One board would then have in its charge these public improvements throughout the Metropolitan District. It would have the advice, assistance and restraining influence of a council composed of the officials whose duty it is to make up the budgets in all of the 39 cities and towns comprising Metropolitan Boston. The meetings, discussions, and even the differing opinions of these bodies would, without fail, bring out ways in which local conditions could be improved, and create better feeling and cooperation among neighboring communities, and thus united action could be taken for the benefit of the whole district. The creation of such a commission to control all metropolitan highways and to take over the present comparatively light administrative work of the Metropolitan Park Commission and the Metropolitan Water and Sewerage Board (including the now practically completed work of the Charles River Basin Commission, which the Metropolitan Park Commission inherits) would retard no public work. It would give increased efficiency and reduced cost, and at the same time establish the proper foundation for the new development of the resources of the district.

A Civic Center for Boston.

One of the most interesting sections of the report deals with a civic center for Boston, with particular attention to a possible site for a new city hall. The Public Gardens, the old Providence depot property and Copley Square are discussed. While no specific recommendation is made, it would appear that the choice of the committee, all things considered, would be Copley Square, on which are located the Public Library and Trinity Church.

Mr. FitzGerald's Harbor Improvement and Free Port Plan.

In his separate report dealing with these subjects, Mr. FitzGerald embodies [illegible] of the results of his recent observations [illegible] the dock and harbor systems of Europe. We [illegible] te from his report as follows:

A convenient and ample area must be sought where commodious railroad yards may be established, and where the ocean business of the Boston & Maine and the Boston & Albany may expand indefinitely, and where, at the same time, any other dock requirements of the port may be met.

There is, in the opinion of the writer, one large area which stands out conspicuously beyond the others in adaptability to the formation of a large port. The idea of a large port may seem somewhat visionary in connection with Boston. After a visit to the principal ports of Europe during the past summer, the writer has changed his whole point of view in connection with the question of docks for Boston.

It does not follow because a plan is made looking a long way into the future that it means an immediate carrying out of the whole plan. It simply means that each link in advance as it is built falls naturally into line with one comprehensive plan of development, varied according to the changes of the time, but always with ample room for growth, without waste of expenditures already made or the destruction of valuable property for additions. This is the course now pursued by every port in Europe.

The area to which the writer alludes adjoins East Boston where convenient railroad connections may be secured with both the Boston & Maine and the Boston & Albany. The latter will expand naturally into the area as traffic increases, and a short link will connect the Boston & Maine.

The space includes the flats adjoining East Boston to the east, with Noddle Island and Bird Island flats, Apple Island and Governor's Island and the flats adjacent thereto, and some of the flats controlled by the East Boston Company. The greater proportion of the area is now owned either by the government, the state or the city, and the title to a portion is now in litigation. The whole area comprises not far from 4 sq. mi., and is, in brief, a magnificent situation for a comprehensive dock system such as will supply the needs of a very large port.

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Both plans show a large area, ranging from 525 to 650 acres, to be devoted to the establishment of a free port. Free ports are found in several continental cities, notably Hamburg and Bremen. In Hamburg particularly the free port has done much to add to the wealth and prosperity of that wonderful port.

Whatever the size of a free port in Boston Harbor, it would be surrounded by a fence or other barrier. Inside of that barrier customs would be unknown, although the free port would be under strict customs supervision. The area might contain docks, warehouses, manufactories, a power-house, railway tracks and other accessories, such as rooms for the display of foreign goods. Here our merchants could examine the goods of foreign manufacturers as freely as by making a trip abroad and order their importations. A little industrial community would be formed where every modern invention could be brought to bear in the interests of economy and the saving of time.

Before a free port could be established in Boston federal legislation would be necessary. * * *

By the scheme proposed a new inner harbor would be formed, reaching from East Boston nearly to Point Shirley, its water surface having a length of something more than 2 mi. and a width of nearly ½-mi. This area, together with the docks and channels, should be dredged to a depth of 40 ft. below low water. The material thus obtained would be used for the filling of the piers and other areas. By this method of construction a large harbor can be created at comparatively small expense.

A suggestion made by Mr. FitzGerald which might be carried out with great advantage in some other ports besides Boston is worth quoting, as follows:

One of the most immediate of the many facilities required in Boston Harbor is some well-equipped pier where passengers may be comfortably landed. Such a pier should be built as nearly fireproof as possible, and should contain every modern convenience for the public—ample shed room, with railroad, trolley and carriage connections, and with permanent and commodious quarters for customs officials. There is hardly any more forlorn position in which invalids or aged persons returning from abroad can find themselves placed than in transferring from steamer to shore with all its attendant delays and inconveniences. These should be reduced to a minimum and a process now anticipated with dread transformed into one of real pleasure. Possibly the Commonwealth pier at South Boston might be adapted to this purpose.

Mr. FitzGerald's report was supplemented by observations on the dock systems of London, Bristol, Havre, Antwerp, Rotterdam, Bremen, Liverpool and Hamburg.

A FIRE DESTROYED THE WINDSOR HOTEL, at Cornwall, Ont., early in the morning of March 23. Of the 32 guests, three died in the flames, two were seriously injured and those who escaped were unable to save even their clothing. The fire started on the first floor and was discovered at about 1 a. m. The hotel, a three-story brick building, was well supplied with fire escapes, but there is said to have been no nightwatchman and the fire was discovered and the alarm spread by the guests themselves. The fire gained such headway before the inmates were aroused that most of them were unable to reach the escapes, but saved themselves by jumping from the windows. The fire brigade reached the scene only after the fire had spread throughout the building and nothing could be saved.

A MINE CAGE CABLE BROKE at a mine near Zwickau, Germany, March 27, and the cage fell about 100 ft. to the bottom of the shaft. The cage was packed with miners who were being lowered into the mine to begin the day's work. It is reported that 24 persons were killed and about 20 others injured.

THE FALL OF A WALL at the butterine plant of Swift & Co., in Chicago, Ill., March 25, killed seven men and injured a dozen others. The wall was of brick and was about 35 ft. high. It had been left standing after the fire which destroyed the plant a month ago. The victims were at work on foundations for a new building only a few feet from the weakened wall.

A POWDER MILL EXPLOSION at Parlin, near South Amboy, N. J., March 24, killed one and injured another official of the International Smokeless Powder Co. Reports state that the company was testing a new method of extracting acid from guncotton at the time of the accident.

A TORNADO IN TEXAS swept over the northeastern part of Wise County, March 23. The small towns of Slidell, Oliver, Bolman, Crawford and Brumlow suffered almost complete demolition. Twelve persons were killed and about twice that number were injured.

THE SLOOP "KEARSARGE," a boat of about 25 tons burden, went down March 13 off the coast of Nicaragua, between Monkey Point and Greytown. Twenty-one persons were drowned, while the captain and seven others reached shore in a small boat.

AN EXPLOSION OF DYNAMITE at Indian Creek, near Chillicothe, Ohio, March 30, killed eight workmen and injured 20 others. Reports state that 400 lbs. of dynamite had been placed around a campfire to thaw. The men employed on the new tracks of the Norfolk & Western were sitting around the fire when the explosion took place.

GAS FROM A BLAST FURNACE was forced into the engine and boiler room of the Illinois Steel Co.'s plant at Joliet, Ill., March 27, by a "slip" in the No. 1 furnace. An explosion followed which is said to have unroofed the engine room and entirely demolished the equipment. Four persons are reported killed and six others were badly injured.

A HEAD-ON COLLISION on the Pittsburg & Butler Street Ry., near Bryant Station, Pa., March 27, resulted in the death of four persons and the injury of about 15 others. The accident occurred near a curve which prevented the motormen seeing each others' cars in time to prevent the collision. One car had just been delayed an hour at Mars, Pa., by a wreck on the Baltimore & Ohio R. R., near the grade crossing, and it is claimed that the subsequent collision was due to a mistake in orders resulting from this confusion of the regular schedule.

THE BLACKWELL'S ISLAND OR QUEENSBORO Bridge across the East River from 60th St., Borough of Manhattan, to Ravenswood, Borough of Queens, N. Y. City, was opened on March 30. Only the driveway and the footwalks were put into use, however, there being no trolley-car connections. The four elevated-railway tracks on the upper deck have been found to exceed the safe carrying capacity of the trusses, in an investigation made last summer, as fully reported in our issues of Nov. 12 and 19, 1908. Since then the city authorities have decided to retain two of these tracks, however, by removing equivalent dead weight. But there is now no elevated-railway near the bridge, and no prospects of one being built to cross the bridge, at least for years to come.

A FREIGHT TRAIN STRUCK A SAND SLIDE on the Union Pacific R. R. March 24, between Granger and Green River, Wyo. The locomotive and five cars were wrecked and two trainmen were killed.

A similar accident occurred March 25 on the Virginian Ry. at Rock Tunnel, south of Huntington, W. Va. A tramp was killed and three trainmen fatally injured.

WEST STANLEY COAL MINE explosion at Durham, England, which was noted in these columns Feb. 18, has been definitely ascertained to have killed 168 miners. The bodies of 166 of these have been recovered from the workings.

A REMARKABLY FAST LONG-DISTANCE RUN was made by a special train on the New York Central Lines between New York and Chicago on March 28. The train was engaged by a New Yorker whose mother was dying in Chicago. It left Scarborough, N. Y., about 30 miles from New York City, at 12.25 a. m. and reached Chicago at 3.07 p. m. (Central time). The distance from Scarborough to Chicago via the New York Central & Hudson River and the Lake Shore & Michigan Southern is 950 miles, and as it was covered in 942 mins. its average speed was 60.5 mi. per hr. There were stops at Albany, Syracuse, and Buffalo, N. Y.; Cleveland and Toledo, Ohio, and Elkhart, Ind., totaling 24 mins. The time excluding stops was therefore 918 mins. for 950 miles, a speed of 62.1 mi. per hr. The fastest section of the run showed considerably higher average speeds, of course. The entire run was made without the help of the best express engines, these being all in service.

It is said that a much faster run over the same route was made some time ago, privately by the railway company, to study the possibility of faster service between New York and Chicago. The distance of 975 miles is said to have been made in 14 hrs., or 840 mins., a mean speed of 69.6 mi. per hr.

THE FREIGHT-CAR SURPLUS on March 17, 1907, was 291,418, showing a slight decrease (8,507) in the two weeks preceding. The decrease is due mainly to coal cars, while idle box-cars increased by 5,000. The chief improvement occurred in the New York-Pennsylvania group, where the number of idle cars decreased by 17,000.

A COLLISION ON A CURVE IN A CUT on the Canadian Pacific Ry., March 27, near Brandon, Man., resulted in the death of three railway employees. Both locomotives of the colliding trains, an eastbound freight and a westbound passenger, were practically demolished, together with an express car and five freight cars loaded with wheat. The accident is ascribed to the failure of the passenger train to obey orders to take the south track from Brandon to Kemnay.

A "LAST SPIKE" of the Chicago, Milwaukee & Puget Sound Ry. was driven at Missoula, Mont., on March 29. This is the Pacific extension of the Chicago, Milwaukee & St. Paul Ry., and extends from Evarts, S. Dak., to Seattle, Wash., crossing the main range of the Rockies on the Montana-Idaho line at St. Paul Pass, a short distance northwest of Missoula, Mont.

IRRIGATION WORKS ON THE FLATHEAD INDIAN Reservation were provided for in the Congressional Indian Appropriation Bill passed March 3, 1909. A total appropriation of $250,000 was made, of which $100,000 is immediately available. The Secretary of the Interior has directed that works be constructed at once to irrigate three tracts, known as the Jocko unit of 6,000 acres, the Mission unit of 6,000 acres, and the Polson unit of 3,000 acres. These areas, it is expected, will be extended later. Opportunity will be given to Indians to take up this work and to make use of their teams. The reservation is located between the Northern Pacific and Great Northern railroads, in western Montana.

Personals.

Mr. Henry F. Hill, M. Am. Soc. C. E., has been elected City Engineer of Augusta, Me.

Mr. H. Foster Bain, M. Am. Inst. M. E., has resigned as Director of the State Geological Survey of Illinois to become Associate Editor of the "Mining and Scientific Press."

Mr. George Boyce, Signal Engineer of the Chicago, St. Paul, Minneapolis & Omaha Ry., has become Superintendent of Telegraphs and Signals, succeeding Mr. H. C. Hope, deceased.

Mr. C. M. Jump has been appointed General Canal Superintendent of the North Platte Project, Wyoming. Mr. Jump has served for the past six years as a district water commissioner under the State Engineer of Colorado.

Mr. H. E. Beasley, formerly Superintendent of the Pacific division of the Canadian Pacific Ry., has been appointed Superintendent of Construction and Operation for the Esquimalt & Nanaimo branch on Vancouver Island.

Mr. J. Frederick Jackson, formerly Assistant City Engineer of New Haven, Conn., has associated himself with A. William Sperry (incorporated) of that city, and will look after the general engineering and surveying work of the firm.

Mr. A. H. Van Cleve, M. Am. Soc. C. E., Consulting Engineer of the Niagara Falls Power Co. and its allied companies, with which he has been connected for the past 17 years, has become General Manager of the Cobalt Hydraulic Power Co., Ltd., of Cobalt, Ont.

Mr. William Barclay Parsons, M. Am. Soc. C. E., who was elected several weeks ago a director of the Underground Electric Rys. Co. of London, Ltd., sailed March 23 for England, where he will study the transportation problems of London in the interests of that company.

Mr. George S. Greene, Jr., M. Am. Soc. C. E., of New York City, and Mr. Henry S. Adams, M. Am. Soc. C. E. of Boston, Mass, have been appointed Consulting Engineers of the City of Newark, N. J., to pass upon the Advisory Commission's report on docks and meadow reclamation.

Mr. L. P. Breckenridge, M. Am. Soc. M. E., Professor of Mechanical Engineering, University of Illinois, will succeed Mr. Charles D. Richards, M. Am. Soc M. E., as Professor of Mechanical Engineering at the Sheffield Scientific School, Yale University. Prof. Breckenridge will assume the duties of his new position in September, 1909.

Mr. L. C. L. Smith, M. Am. Soc. C. E., Assistant Engineer, Department of Water Supply, Gas and Electricity of New York City, has been placed in sole charge of all engineering matters, including pumping station improvements, in Queens Borough. Mr. I. M. De Varona, M. Am. Soc. C. E., Chief Engineer of the department, is relieved from further supervision in Queens Borough.

Mr. Robert Thurston Kent has resigned as Engineering Editor of the "Iron Trade Review," Cleveland, Ohio, to become Managing Editor of "Industrial Engineering," Pittsburg, Pa., a new paper devoted to mechanical engineering subjects. Mr. Kent has been with the Iron Trade Review since 1905, and prior to that time was Associate Editor of the "Electrical Review," New York City.

Messrs. Walter P. Hirschberg, Lester D. Williams and Frank E. Washburn have opened an office as designing and constructing civil engineers in the Stephenson Bldg., Milwaukee, Wis., with the firm name of the Hirschberg - Williams - Washburn Co. Mr. Hirschberg was formerly with the U. S. Steel Corporation, Gary, Ind.; Mr. Williams was with the Northwestern Tile Co., Milwaukee, Wis.; Mr. Washburn with Ralph Modjeski, consulting engineer, Chicago, Ill.

Mr. Augustus Mordecai, M. Am. Soc. C. E., has opened an office as Consulting and Constructing Engineer at 1328 Citizens' Bldg., Cleveland, Ohio. He has recently been engaged with Mr. John F. Stevens, Vice-President of the New York, New Haven & Hartford R. R., in the work of making a valuation of the physical property of that railway. Previously to that work, which was concluded in 1908, he had been for several years Engineer of Maintenance-of-Way on the Erie R. R.

Promotions of officers of the Pennsylvania R. R., resulting from the retirement of Mr. John P. Green, First Vice-President, are announced as follows:

Mr. Chas. E. Pugh, previously Second Vice-President, becomes First Vice-President, in charge of pension, insurance, real estate and purchasing departments.

Mr. Samuel Rea, previously Third Vice-President, becomes Second Vice-President, in charge of the engineering and accounting departments.

Mr. W. W. Atterbury, M. Am. Soc. M. E., previously General Manager, becomes Fifth Vice-President, in charge of the Transportation department. Mr. Atterbury is a graduate of Yale University. He entered the service of the Pennsylvania R. R. in 1886 as an apprentice in the Altoona shops and was steadily promoted, becoming General Manager in 1903.

Mr. W. Heyward Myers, previously General Superintendent of the Northern Central Ry. and the Erie division, is appointed General Manager. Mr. Myers was educated at the School of Mines of Freiberg, Germany, and entered the service of the Pennsylvania R. R. in 1876 as a rodman. He served subsequently on various divisions as an assistant supervisor, supervisor, assistant engineer and superintendent. He was appointed General Superintendent, Philadelphia & Erie R. R. division and Northern Central Ry., in 1900.

Mr. H. M. Carson, previously Assistant to the General Manager, is appointed to succeed Mr. Myers as General Superintendent. Mr. Carson was a graduate of Lehigh University, class of 1889. He entered the employ of the Pennsylvania R. R. Co. in 1889 as a special apprentice at the Altoona shops and was steadily promoted, becoming Superintendent of Motive Power of the Buffalo and Allegheny Valley division in 1901 and Assistant to the General Manager in 1906.

Mr. J. G. Rodgers, previously Superintendent of the New York, Philadelphia & Norfolk R. R., is appointed Assistant to the General Manager. Mr. Rodgers was educated at Lehigh University and entered the employ of the Pennsylvania R. R. in 1882. He became Superintendent of the New York, Philadelphia & Norfolk in 1900.

Obituary.

Julius W. Schaub, M. Am. Soc. C. E., long engaged in consulting practice as a civil engineer in Chicago, was found dead in a Pullman berth en route from New York to Chicago, on March 30. It is reported that he committed suicide. A fuller note of his career will be given in our next issue.

John H. Francisco, Township Engineer of Belleville, N. J., for more than 30 years, died March 25 at his home in Newark, N. J. He was born at Belleville in 1850 and was educated at the Bloomfield Seminary.

Mark T. Cox, senior partner of the firm of Robert Winthrop & Co. of New York City, died March 23 at his home in East Orange, N. J., aged 56 years. Mr. Cox was a director of the Lackawanna Steel Co., Allis-Chalmers Co., Wisconsin Central R. R. Co., Chicago Junction Rys. and Union Stock Yard Co., and of the Public Service Corporation of New Jersey.

C. C. Harvey, formerly President of the New Orleans & Northeastern R. R. and other lines of the Queen & Crescent Route, has been reported as having died in Europe. Mr. Harvey was born in Newfoundland in 1846, and, in 1864, entered railway service in the accountant's office of the London, Brighton & South Coast Ry., in England. He came to this country in 1883 as Assistant General Manager of the Cincinnati, New Orleans & Texas Pacific Ry., a part of the Queen & Crescent Route. He became President of the southern lines of the same railway system in 1894 and held this position for at least twelve years.

Thomas Fitzgerald, Receiver and General Manager of the Norfolk & Southern Ry., died March 28, at Baltimore, Md. Mr. Fitzgerald was born at Fairmont, W. Va., Jan. 1, 1853 and entered the employ of the Baltimore & Ohio R. R. in 1866 as a water boy on the Monongahela bridge. He was subsequently a telegraph operator, train dispatcher, chief train dispatcher, superintendent and general superintendent of various branches of the same railway. He became General Manager of the Baltimore & Ohio R. R. in February, 1905, and resigned that position in January, 1908. In July, 1908, Mr. Fitzgerald became co-receiver of the Norfolk & Southern and remained in this position up to the time of his last illness.

William P. Henszey, member of the firm of Burnham, Williams & Co., operating the Baldwin Locomotive Works, died March 23, at his home in Philadelphia. Mr. Henszey was born in Philadelphia in 1832 and was graduated at the old Philadelphia High School in Juniper Street. He entered the employ of the Baldwin Locomotive Works in 1859 as an engineer and draftsman and has remained with that firm, through all its changes of title, up to the time of his death. During the 50 years that he has been in charge of locomotive design, the Baldwin works have completed more than 32,000 locomotives. Mr. Henszey received the degree of Doctor of Science from the University of Pennsylvania in 1906. He is survived by his wife, formerly Anne B. Hitchcock, of Abington, Mass., and a daughter, who is now Mrs. Thomas G. Ashton, of Philadelphia.

Jasper R. Rand, Vice-President and Director of the Ingersoll-Rand Co., died of pneumonia in Salt Lake City on March 30. He was the son of Jasper Raymond Rand, one of the founders of the Rand Drill Co. Born in Montclair, N. J., September 3, 1874, he was graduated from Cornell University in 1898, and served in Porto Rico in the Spanish-American war as a member of the First New York Volunteer Engineers. During 1899-1900 he was president of the Imperial Engine Co., at Painted Post, N. Y., from 1900 to 1905 President of the Rand Drill Co., and since 1905 Vice-President and Director of the Ingersoll-Rand Co. Mr. Rand was a member of the American Institute of Mining Engineers, and of the American Society of Mechanical Engineers. He is survived by one sister, Mrs. Henry Lang, now traveling abroad.

George Albert Converse, Rear-Admiral, U. S. N., retired, died March 29, at his residence in Washington, D. C. He was born at Norwich, Vt., in 1844, and was educated at the schools of that place and at Norwich University, where he studied for three years, receiving the degree of B. S. He was graduated at the U. S. Naval Academy in 1865 and became an ensign in 1866, master in 1868, lieutenant in 1869, lieutenant commander in 1878 and commander in 1889. Ten years later he rose to the rank of captain and he was made a rear admiral in 1904. Much of Rear-Admiral Converse's work was in connection with the torpedo service. He was Chief of the Bureau of Equipment, 1903-4, Chief of the Bureau of Ordnance from March to August, 1904, and since that time has been Chief of the Bureau of Navigation, retaining this position after his retirement for age in May, 1906, at the special request of the President.

Charles Herbert Deans, Assoc. M. Am. Soc. C. E., died at his home in Phoenixville, Pa., on March 7, 1909, after a week's illness of pneumonia. Mr. Deans was the son of the late Charles Woodbury Deans and was born in Chester, Pa., in 1863. After receiving a thorough preparatory education, he entered Lehigh University in 1885, graduating in 1889 with the degree of C. E. Immediately after graduation he entered the employ of Sooysmith & Co., foundation engineers and contractors, and rapidly advanced to positions of responsibility, becoming Vice-President and chief executive officer of that company in 1895. Upon the retirement from active business of Mr. Charles Sooysmith a year or two later, Mr. Deans organized, from the Sooysmith & Co. staff, the Engineering Contract Co., of which he became President. The pressure of business seriously undermined his health and in 1900 Mr. Deans was forced to temporarily give up all work and spent two years in the mountains of northern Pennsylvania.

Upon regaining his health, he associated himself with the well-known firm of John Monks & Son, of New York, and at the time of his death he was Vice-President of this company.

In addition to his thorough technical training Mr. Deans, from personal contact and experience, had an extensive knowledge of all the details of the foundation business. While in executive charge of the business of Sooysmith & Co. and the Engineering Contract Co., he constructed a number of the most important bridge foundations throughout the United States and was among the first to successfully use pneumatic caissons in the foundations of the modern high office buildings of New York, notably the Manhattan Life, Washington Life and Empire buildings of lower Broadway. At the time of his death he was in full charge of construction of piers of the reconstructed B. & O. R. R. bridge over the Susquehanna River at Havre de Grace, Md. Mr. Deans combined with his technical and professional knowledge an unusual business ability and being extremely orderly and methodical in his habits he was able to handle the details of large work readily. He made friends easily and held them by his loyalty and fine character. His whole life work was on the highest plane of professional integrity and square dealing with his official associates and his men. Mr. Deans leaves a wife and two sons, aged 12 and 14 years, a brother, John Sterling Deans, Chief Engineer of the Phoenix Bridge Co., and two married sisters.

Engineering Societies.

COMING MEETINGS.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION.
April 27 to 30. Annual meeting at Louisville, Ky. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 4-7. Spring meeting at Washington, D. C. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 6-8. Annual meeting at Niagara Falls, Canada. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AIR BRAKE ASSOCIATION.
May 11-14. Annual meeting at Richmond, Va. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
May 18-20. Annual meeting at Cincinnati, Ohio. Secy., Richard Moldenke, Watchung, N. J.

AMERICAN RAILWAY ASSOCIATION.
May 19. Annual meeting at New York City. Secy., W. F. Allen, 24 Park Place, New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 25-27. Annual meeting at New York City. Secy., W. H. Merrill, 382 Ohio St., Chicago, Ill.

AMERICAN WATER-WORKS ASSOCIATION.
June 8-12. Annual convention at Milwaukee, Wis. Secy., John M. Diven, 14 George St., Charleston, S. C.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 16-18. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 21-23. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 39 Old Colony Bldg., Chicago, Ill.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
June 21-23. Annual meeting at Chicago, Ill. Secy., D. B. Sebastian, C. & E. I. R. R., 327 La Salle Station, Chicago, Ill.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 23-25. Annual meeting at Detroit, Mich. Secy., P. W. Drew, Wisconsin Central Ry., Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 28. Annual convention at Frontenac, N. Y. Secy., Ralph W. Pope, 33 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 29-July 3. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN ELECTROCHEMICAL SOCIETY.—The first day of the annual convention to be held at Niagara Falls, N. Y., May 6-8, will be devoted to papers on metallurgy of iron and steel. These papers will take up various types of electric furnaces including the Kjellin, the Girod and the Heroult types.

MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.—A meeting was held March 24 in the Engineering Societies' Bldg., New York City, at which Mr. Herman W. Merkel, Chief Forester, New York Zoological Park, presented a paper, entitled "Some Interesting American Trees." The paper was illustrated by lantern slides. Members and guests of this society will inspect the Queensboro Bridge March 27, meeting at the Manhattan entrance at 2 p. m.

NEW YORK RAILROAD CLUB.—At its meeting held in New York City March 19, the general topic for discussion was the electrification of railways. The question of standardization of electrification was given considerable attention, and some of the speakers treated "The Approaching Transfer of the Electrification Problem." Among those who spoke were Mr. L. B. Stillwell; Mr. Wm. S. Murray, Electrical Engineer of the New York, New Haven & Hartford R. R.; Mr. N. W. Storer, Westinghouse Electric & Mfg. Co.; Mr. Henry G. Stott, New York; Mr. C. L. de Muralt, New York; Mr. Wm. McClellan, New York, and Mr. Frank J. Sprague, New York.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—At the first annual meeting, which is to be held June 21-23, in Chicago, committee reports will be presented on the following five subjects: 1. Proper methods of purchasing fuel with regard to operating and traffic conditions, considering also the permanent interests of the producer when located on the consumers' rails. 2. Standard types of coaling stations; best design and most economical coal chute for handling coal from cars to locomotives. 3. Best method of accounting for railway fuel, including movement from mine through coaling station to engines, up to monthly balance sheet. 4. Difference betwen mine and destination weights; legitimate shrinkage allowable on carload lots. 5. Difficulties encountered in the production of clean coal for locomotive use.

THE FOUR NATIONAL ENGINEERING SOCIETIES.—A meeting will be held April 13 at the Engineering Societies Bldg., under the auspices of the John Fritz Medal Board. The occasion of the meeting is the presentation of the John Fritz medal to Mr. C. T. Porter, Hon. M. Am. Soc. M. E. The medal for 1909 has been awarded to Mr. Porter for his work in advancing the knowledge of steam engineering and in devising improvements in engine construction. In addition to the presentation ceremony, there will be addresses as follows: "The Debt of Modern Industrial Civilization to the Steam Engine as a Source of Power," W. F. M. Goss, M. Am. Soc. M. E. and Am. Inst. E. E.; "The Debt of the Modern Steam Engine to Mr. Charles T. Porter," F. R. Hutton, Hon. Sec. Am. Soc. M. E.; "The Debt of the Era of Steel to the High-Speed Steam Engine," Robert W. Hunt, M. Am. Soc. E. E., Past-President Am. Soc. M. E. and Am. Inst. M. E.; "The Debt of the Era of Electricity to the High-Speed Steam Engine," Frank J. Sprague, M. Am. Inst. M. E. and Am. Soc C. E.

THE CONCRETE INSTITUTE.—This English association was formed July, 1908, by a number of well-known British engineers and concrete specialists with the following objects:

To advance the knowledge of concrete and reinforced concrete, and direct attention to the uses to which these materials can be best applied.

To afford means of communication between persons engaged in design, supervision, and execution of works in which concrete and reinforced concrete are employed. . . .

To arrange periodical meetings for the purpose of discussing practical and scientific subjects bearing upon the application of concrete and reinforced concrete, and to conduct such investigations and to issue such publications as may be deemed advisable.

The officers of the institute contain a number of noteworthy engineers well known in this country as well as abroad. The president is the Earl of Plymouth and the vice-presidents, Sir Douglas Fox, Sir Wm. Mather, Sir Wm. Preece and Sir Henry Tanner, while among the executive committee are such men as Wm. Dunn, Charles F. Marsh and Lt.-Col. Winn, all of which names are familiar to American engineers.

From the first volume of "Transactions and Notes," published in February, 1909, we would judge that the proceedings of the institute are to be carried on in a different, if not higher, plane than those of its American analogue, the National Association of Cement Users. These "Transactions" are largely made up of two papers, respectively presented at the first and second meetings; one by Mr. Charles F. Marsh on "The Composition and Uses of Plain and Reinforced Concrete," and the other by Mr. William Dunn on "The Examination of Designs for Reinforced-Concrete Work." These papers are the careful work of two specialists and are followed by well thought out discussions, though it is evident from the latter that up to now most of the concrete work in the United Kingdom has been in the hands of specialists, for the most part contractors exploiting certain patented systems, and that the average engineer is more in the position of an earnest student than of an expert capable of giving advice. There is, however, in the whole attitude of the institute a certain dignity which seems to be in accord with that of the four national societies in this country. That is, the institute is an association of engineers interested in concrete and not a society of those whose whole attention is devoted to cement products. The latter undoubtedly serves a useful purpose, but it can hardly expect to have the professional membership or standing that a society such as the Concrete Institute must surely attain.

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